THE

ENGINEERING MAGAZINE

VOL. IV. JANUARY, 1893. NO. 4.

DO WE NEED STATE-BANK CURRENCY?

By Edward Atkinson.

I HAVE been requested to prepare an article showing the relationship of a State bank note currency to the needs of large industrial enterprises, and I very gladly accept the invitation; but, in order to do so at this time, it will be necessary for me to repeat much that I have said upon other occasions in discussing the same general subject.

The men who are actively engaged in the industrial development of our country are more vitally concerned in having a sound and sufficient volume of currency than any other class of business men. The construction and equipment of a railroad or a street railway, the building of a water works, or the establishment of an electric light plant are enterprises requiring such enormous sums of money that their engineers and promoters are constant frequenters of the money centers, and always in the position of borrowers. Proper "financial engineering" has come to be recognized as a prerequisite of success in every such undertaking, and not until this essential feature of every large undertaking is in the hands of expert financiers, who can assure the sale of the securities, is it possible to begin active work.

Now, if the money markets are easy, the bank reserves well above the legal limit, and capital seeking investment, legitimate enterprises in the hands of competent men and offering good securities experience no difficulty in borrowing money at fair rates of interest. But if ready money be scarce, and especially if the banks have difficulty in maintaining the legal reserve, it is practically impossible to borrow except at exorbitant and often hazard-

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ous terms. The inevitable result is that legitimate enterprise is forestalled, and, no matter what the stage of development, operations must be suspended to await more favorable conditions of the money market. For these reasons it is essentially important, not only that such men should understand the currency question, but that they should throw the full weight of their influence towards the proper solution of our present problem.

Under the stress of the war, it became necessary for the national Government to collect a forced loan by the issue of the legal tender notes known as greenbacks. It also became expedient to establish the national-bank system, for the purpose of borrowing the capital of the banks to the extent of the circulating notes that might be issued by them. The Government retained possession of the bonds issued as evidence that such capital had been borrowed, and authorized the banks to issue national-bank notes, not legal tender, secured by the deposit of these bonds.

The system has proved to be an admirable, excellent, and safe system; its merits are recognized, without any distinction of party, by all who are conversant with the functions of banks and bankers, but neither the legal-tender act nor the bank act was passed for the purpose of supplying people with money or instruments of exchange of any kind. That was an incident to the forced loan and of the issue to secure bank notes. The whole series of acts were war measures, or acts for borrowing.

The fault in this system, now admitted without distinction of party, is its lack of elasticity and the difficulty in maintaining a safe circulating medium so as to meet the increasing demands of the country due to its rapid growth, from which has ensued a need of additional notes or instruments of exchange.

The issue of national-bank notes long since ceased to be sufficiently profitable to the banks to induce them to maintain the bank-note circulation; hence, while the increasing need of the country has been felt, the bank-note circulation has been greatly reduced. The popular cry of a few years since for more greenbacks, and the recent demand, especially in the South and the far distant West, for the free coinage of silver dollars, may be almost wholly attributed to the lack of elasticity in the circulating medium, consisting of a limited amount of United States legal-tender notes and national-bank notes.

The increasing demands of the country for more notes or some kind of instrument to be used as money suitable to be passed

from hand to hand in small transactions has enabled the country to absorb the silver notes issued as a representative of the silver in the treasury. The necessary use of these silver notes in daily transactions, in connection with other forms of circulating medium, has up to this time prevented their being returned for redemption to the treasury in any dangerous manner; thereby the treasury has been enabled to maintain the whole volume of currency up to this time at a parity with the lawful unit of value, or gold dollar.

How long can this course be continued?

It has long been manifest that a substitute must of necessity be found for the national-bank note. Sooner or later, earlier, perhaps, than most people expect, the United States bonds which are available to secure the circulation of national-bank notes will be paid or purchased in pursuance of the sinking fund act.

What, then, is the alternative?

Is it rightly the function of the United States Government through Congress to forbid the States by a prohibitive tax from organizing a system of banking, in order to facilitate the traffic of their respective States, or to enable each State or each neighborhood to conduct its own transactions on the security of the capital and credit of its own citizens?

It should be remembered that the great volume of banking capital under the national-bank act is held in the eastern and middle northern States. This is already a subject of prejudice to persons, without respect of party, who are not fully conversant with the functions of banks and bankers.

They are jealous of the restrictions on banking, and if the national Government lends itself to what may be held to be a monopoly of the functions of the banks of issue, there would be much greater danger of the unlimited issue of United States legal-tender notes, or of silver dollars of the present standard without regard to any agreement of national legal tender, than there will be if States are permitted to charter banks of issue to serve their own citizens.

Through the application of science and invention to the field, the farm, and the factory since the restoration of the specie standard in 1879, the total product of this country has been enormously increased; with that increase has come a corresponding increase in business transactions or exchanges, of which, perhaps, the surest demonstration may be made by examining the figures of the traffic of our railways. Since the year 1881 the volume of freight moved by railway only in this country has increased 64 per cent., against

a probable increase of population of less than 19 per cent. There has been a corresponding increase in traffic by waterways, the whole volume of which is about one-quarter as much as the railway traffic. This additional movement by railway only comes to 340,000,000 tons of food, fuel, fibers, and fabrics,—hauled 113 miles on the average.

If this is computed at only $20 per ton, it represents in the first transaction only an increase of business exchanges amounting to $6,800,000,000 in a single year. Unless one has the kind of imagination which is developed by practice in dealing with these great sums, these facts convey little or no impression to the mind.

Now by far the larger part of the increase of this traffic by railway consists in drawing products from more and more distant sections, where there has been no increase in the banking facilities; hence the absorption of every kind of note and coin,—legal-tender notes, bank notes, gold certificates, silver certificates, or other representatives of money, as well as silver dollars, which have thus far maintained their parity with gold through government redemption.

Are the people in these far distant States and territories to be deprived of or forbidden to provide themselves with a currency or circulating medium, which is not capable of being forced upon any unwilling person, but which may rest wholly upon the confidence and credit reposed in the management of local banks by the people of that special neighborhood, secured in such a way as each State may find suitable and safe?

The effect of the prohibitory tax upon State bank notes is to deprive States of the opportunity to serve themselves. It is a merely partisan pretence to say that this is a movement to go back to the "wildcat" currency of fifty years ago.

There is need of the adjustment of our circulating medium to the present conditions of our internal commerce; the first and essentially necessary step toward that adjustment is the repeal of this tax on State bank notes. Otherwise no Congress will be able to resist the cry for more money, either in the form of legal tender notes, greenbacks, silver dollars, or some other kind of currency, probably of unsafe quality.

Is it not an utter absurdity to assume that in these days of quick communication a State bank can force an unsound and unsecure bank note, which is not a legal tender, upon the community?

How is the great volume of transactions now liquidated? What are the facts of the case?

Ninety-five per cent. of all business transactions, perhaps a little less, probably a little more, are now liquidated by means of checks, bills of exchange, or drafts, which are not a legal tender, but which constitute the principal circulating medium of our great and increasing traffic.

Yet the Government does not attempt to exercise any supervision in respect to these drafts, checks, and bills of exchange. Their use is voluntary, and the Government is called upon to intervene only when default occurs in payment.

Again, it is perfectly competent for any person, firm, or corporation to issue checks upon a bank in which money is deposited for any sum in even dollars from one to thousands. Such checks may be used in liquidation or payment of obligations for goods or for wages. Undoubtedly checks paid out for wages or services are very often passed on by him who has received them to the grocer or butcher in his neighborhood or town. They are then sent by the grocer or butcher or the small tradesman to the dealer in the city from whom he buys his goods. Such checks are finally sent in for redemption by the city merchant.

This is not so common a practice as in any considerable measure to effect or add to the circulating medium ; but it is a limited practice, and there is no law against it.

It is also perfectly competent and suitable for any individual in any town to buy produce from his neighbors and to pay with his checks on a bank, either one check or several of $1 to $5 each, provided his neighbors will take them ; but he cannot force such checks into circulation.

The Government undertakes no supervision of checks ; it only intervenes to compel the payment of the check by him who has drawn it, if he has no funds in the bank or if the bank fails. There is no tax upon this medium of exchange ; checks may be used to any extent.

Now, what is a bank note?

It is not lawful money ; that is to say, it is not a legal tender ; it is an obligation of the bank to pay lawful money to the bearer. It cannot be forced into circulation. In other words it is a check drawn or made by the officers of the bank upon the funds of the bank.

If State bank circulation be so prohibited, we may be drawn into the dangerous condition of the Government undertaking to supply the people with lawful money. That means the forced circula-

tion, under an act of legal tender, of legal tender notes or greenbacks at the discretion of any Congress.

On the other hand, let it be assumed that the tax upon State bank circulation is repealed; then may not each State establish its own method of securing the redemption of bank notes payable in lawful money? Must not the State establish the quality and kind of security, if any, to be held by each State under such conditions?

The country is now rich enough to supply itself with all the coin required by travelers who pass from one State to another who might distrust the bank notes. That want could readily be met, even if the existing volume of legal tender notes and national bank notes were wholly withdrawn. But it does not follow of necessity from the repeal of the tax on State bank notes that either the existing volume of national bank notes, legal tender notes, or coin certificates should not continue to be used and to circulate if required. Either of these instruments of exchange, coin or lawful money now existing, would be found to fulfil every requirement that would be met in passing from one city to another.

It is true that bad money or depreciated money, when forced into circulation by an act of legal tender, drives true money or good money out of circulation; but it is equally true that good money of full value, whether legal tender or not, drives bad money out of circulation when that money is not forced upon an unwilling people by an act of legal tender.

Therefore, it follows that if, after the remission of the tax on State bank notes, the States did not legislate wisely for the protection of those who were to be allowed to issue State bank notes, and did not assure their redemption, then the banks could put their notes in circulation. They would be distrusted; or, if paid out, they would be so quickly presented for redemption, under the present conditions of trade, that there would be no profit even in attempting to put them out.

It follows that, if there is to be any remedy for our present difficulties, an adequate, elastic, and adjustable note circulation must be devised, and a first step toward a right solution must of necessity be the repeal of the tax upon the circulation of State bank notes.

Otherwise, as I have previously stated, the eastern and middle States, now holding the greater volume of national bank capital and enjoying the greater part of the right of circulating national bank notes, will be held to have a monopoly: the consequence of that will be a dangerous call from other sections for additional legal

tender currency, or an equally dangerous call upon the Government to coin a low-priced metal like silver into legal tender money. The question at issue in this matter presents but the two alternatives. The question is not, in fact, a party question. Long before the Democratic party adopted the clause in its platform which calls for a repeal of the tax upon State bank notes, that policy had been advocated in many of the principal financial papers of this country, and by many persons of repute who are held to be conversant with finance and banking, without regard to their political affiliations.

Now, let us glance at the conditions which existed two years ago when the Barings failed, and when we approached so dangerously near a disastrous financial panic. They may be concisely stated in the following terms. It was a time of profound peace. We were almost wholly free from any great speculative transactions, either in the construction of railways, works, or factories. Subsequent to the year 1884 and down to the year 1889, inclusive, the country had increased its crops, extended its railway service, opened its mines, developed its trade, and placed itself in a position to produce, distribute, and get the benefit of the greatest abundance of food, fuel, fibers, and fabrics ever placed at the disposal of the people of this or any other country.

The volume of current money was, as it is now, greater *per capita* and represented a larger volume than has been found wholly sufficient throughout a long previous period, in the greater part of which time it has been truly said that "*money was very plenty*." Yet under these extremely favorable conditions of ample and increased product, served by almost an excess of the mechanism of distribution, all prices being moderate and wages as a rule higher than ever before, we yet stood for weeks in the face of an impending disaster due to a scarcity which is erroneously called a scarcity of money; and but for the happiest of all ideas in modern banking—the issue of clearing-house certificates—we should unquestionably have had precipitated upon us a money panic, the cost of which would have been simply enormous. As it was, that stringency of the money market caused a decline in the prices of many important staples, and it reduced the profits of the producers of crude products of the soil and mine at a time when the margin of profit was not large. It rendered a true foresight on the part of the buyers of these crude products impracticable, by depriving them of advances from banks and bankers, by which they would have been enabled to lay in suitable stocks. It enabled those in posses-

sion of very large capital to get an undue advantage in the purchase of materials, over those who had but a moderate and yet sufficient capital to entitle them to credit sufficient to meet the demand of ordinary or normal periods. It deprived manufacturers of a part of the price of goods made from materials which cost more than the semi-panic prices.

This leads me to what I deem the key to the problem: The restrictions which are imposed upon the national banking system by statute law, and the obstructive national taxation by which the people are forbidden to provide themselves with such a currency as is required under our present conditions. I therefore hold that the scarcity to which we were then subjected was not a scarcity of money, but a compulsory refusal of credit wholly due to a scarcity of lawful money *at a particular point*,—to wit, in the bank reserves. A huge proportion of the lawful money of the country is now kept out of the bank reserves for use in circulation and in exchanges in which secured bank notes might be substituted, thus relieving the volume of legal tender money of a duty which ought not to be put upon it. A unit of lawful money in a bank reserve in sustaining credit and moving merchandise may be compared to the force of a locomotive engine, while the same unit of lawful money in your pocket or in mine, waiting to measure only a single petty transaction when passing from our hands to those of another, is like a wheelbarrow in its usefulness.

What is the object of a reserve if the bank is forbidden to make use of it at the time of the utmost need? If the reserve is required at any time, it is required when the credit of the community must be sustained, or else the bank itself may fail. The last thing the people want, however, unless they are afraid the bank is really going to fail, is the kind of money which is in the bank reserve; all they want is some kind of a good and redeemable note with which they can liquidate their obligations. There is not one transaction in a thousand in which it is of the slightest importance whether the obligation is liquidated in money which is a legal tender, or in current money which is not a legal tender. What is needed at such a time is current money based on such a solid foundation that its credit is absolute, whether it be legal tender or not; such a currency may consist of bank notes convertible on demand into coin, or, if the bank fails, redeemable in coin from the sale of securities that will bring the coin as soon as the bank can be put into the process of liquidation.

Now, there is a perfectly simple way of providing an elastic bank note currency of this kind, which will adjust itself from time to time to all the requirements of trade, because it will be, as one may say, the shadow of the substance which will move with the substance, and which will cancel itself in liquidation, through the consumption of the very merchandise of which it is the shadow. We have an excellent example of such a currency in the modern clearing-house certificate, which has already served the banks so admirably. That, plainly stated, is a certificate of associated bankers—the clearing-house—that securities have been deposited by the bank to which the certificate is issued, of a character and in sufficient amount to completely guarantee its redemption in coin.

It is an easy matter to give such a certificate the power of general circulation by printing it upon one side of bank-note paper and giving the bank authority to print upon the other side the customary form of bank-note. I have drafted an act providing for this, the essential features of which are as follows: (1) the division of the country into districts, each having a large city as a center, in which city the banks of the district may organize a clearing-house; (2) the authorization of any national bank to deposit securities up to a certain percentage of its capital with the finance committee of its clearing-house, these securities to be subject to change at the demand or with the consent of the committee; (3) the issue by the clearing-house to the bank of certificates of convenient denominations, to an amount not exceeding 80 per cent. of the value of the deposited securities, these certificates bearing the pledge of the clearing-house to redeem in lawful money on demand, in case of the failure of the bank itself to do so, and reserving the power to sell the securities for this purpose if such an emergency arises; (4) the authorization of the bank to print upon the back of the certificate its obligation to pay the face value of the certificate in lawful money on demand; (5) the exemption of these certificates from the ten per cent. tax on circulation.

This is the sort of "Sub-Treasury" which the farmers' alliances will sustain as soon as they have learned that cheap and abundant supplies of poor kinds of money will destroy credit, lower prices, and increase the very difficulties of the farmers themselves, and when they have also learned that the business of a warehouseman and factor and that the making of advances on crops is about as far removed from the duties with which a government can be safely charged as it is possible for man to conceive.

OUR OUTLOOK FOR FOREIGN MARKETS.

By Albert D. Pentz, M. Am. Soc. M. E.

IN overproduction, it is fair to assume, may be found the greatest disadvantage with which manufacturers have to contend, and it is a matter of fact that the methods of modern mechanical progress constantly tend toward this condition. This is true especially of American progress, because here, as nowhere else, the economies of manufacture are studied closely in every detail and mechanical equivalents for hand operations are introduced to expedite production and to cheapen and simplify the processes. Hence in many lines of manufacture the American market is too restricted for the products of American industries, and naturally a remedy is sought in markets abroad for such goods as are created in surplus over the American demands. Such markets would benefit our manufacturers by adding volume to their business. They would assist labor by supplying more continuous employment, and the general classes would be helped by the restriction of one of the chief causes of hard times and of panics.

There is every evidence that our goods are, in many cases, of such excellence as to be preferred in competition to the goods of all other countries. Comparisons in our own markets show that our machine-made products generally are better than those of European make of the same classes, and that where the qualities are equal the American goods can be produced the cheaper, all other things being equal. In the world's competition, therefore, if Americans are satisfied with the same rate of profit as that enjoyed by European manufacturers, they can not only offer their goods at lower prices, but offer better goods, and by selling great quantities they will thus make more money.

One word may be said in explanation of the above statements to dispel a popular illusion. The comparative price paid for labor per hour has but little effect on the comparative costs of American and European goods. In Europe hand operations largely prevail, and every process in manufacture is burdened with labor costs, making an aggregate in the end of great expense, which cannot be eliminated from the systems that obtain in those countries without decades of training for the operatives, a revolution in government

and in financial methods, as well as the adoption of means to employ, feed, and clothe the persons who would be rendered idle by the methods of manufacture prevalent in America. In this country hand labor is studied to reduce it to a minimum, and tools are invented to supersede it, because tool products are better and more accurate, because tool processes are swifter, because the output from them is less liable to daily variation, and because they are so much cheaper that a competing hand labor is out of the question.

A study of manufacturing on both sides of the Atlantic has suggested the belief that the United States can occupy exclusively the markets of the world with her constructive manufactures *if free to do so.* Who can compete with us in sewing machines, in agricultural implements, in small machine-tools, in shoe-machinery, in hat-machinery, in printing presses and appliances, in steam-engines, in wood working machinery, in furniture, and in all the industrial arts that have attracted the attention of our people? In these things this country could, if permitted by equal terms, at this moment destroy by competition the like arts of every other country in the world. She could invade the markets of the countries employing the cheapest labor and sell better goods cheaper than those produced on the spot. Hence Americans need have no fear of cheap labor or of goods produced by hand, but they may enter with confidence any free market in any civilized country and place distinctive American products of distinctively American quality at paying prices, and sell rapidly. American customers are the most critical and demand the best goods made, and, if such goods satisfy the markets here, they will have a sale anywhere that they may be made known and offered at reasonable prices.

Such countries as Australia, Canada, France, and Great Britain, in the order named, will pay good prices for excellent goods, and it will be folly to attempt to deceive them with trash. The remainder of Europe will be satisfied by inferior goods at cheaper prices; not because they do not desire superior goods, or cannot appreciate them, but because their armies are the sole luxuries they are permitted to hope for or have the means to pay for.

In most European countries the patent laws are vexatious and require that articles patented by foreigners shall be made in the countries granting such favors. This can be avoided by our manufacturers only to the extent of manufacturing the precise part patented in those countries and shipping the remainder of the devices from America. The commercial value of a patent in any European

country, except Great Britain, is extremely problematical. The protection is doubtful, and the competition, if it is a healthy one, does not require protection, for reasons already stated. Tariff duties in most European countries are supposed to be a hindrance to the extension of our trade because they make the American goods cost purchasers more than otherwise would be the case. This increased cost is a fact; but, because the native manufacturer promptly adds a like sum to his profits, the foreign maker of good articles does not suffer severely from that cause in the competition.

In Spain and Portugal our mechanical articles that operate well and sell cheaply are in great demand. The quality of workmanship is not seriously considered, but of two articles of the same kind that which is most gaudily decorated will sell better. All the British dependencies are poor, except Australia and Canada, because the commercial policies of England favor the concentration of wealth at home and the colonies are used merely to furnish consumers, to facilitate transportation of goods toward non-producing peoples, and to produce raw materials for manufacture. What is true of British colonies is true of all other colonies as a rule, and hence colonies are, on the whole, good markets for but limited quantities of cheap goods. Australia and Canada are exceptional only because they have become commercially independent of their political sponsor.

The conditions to be met in exporting goods of American manufacture into the different markets of the world of course vary widely with the different countries to be reached. In England American novelties and small machinery are quite popular, but the market is flooded with "cheap and nasty" German imitations of American goods which are sold by unscrupulous merchants as being of American make. This fact hinders the sale of genuine American goods by as many as are sold under false representations, and their reputation is hurt when buyers are made to believe that such trash is really of American production. Little progress can now be made in introducing the heavier articles of manufacture into Great Britain. English machinery of the heavier kinds is very good, and while the American styles are quicker, cheaper, and handier, British workmen, unfamiliar with them, cannot operate them at once to get the results called for; hence they conservatively prefer the tools they are used to, and often reject a superior tool that is not understood. They as frequently try to adapt a superior machine of great producing power to uses which do not call for the operation of its best

features. Thus an American universal milling machine is seen doing a common operation such as key-seating shafts, and all the "jim-cracks" are either carefully put away or promiscuously thrown into corners to rust away an idle existence. Of course when our special appliances are thoroughly understood and appreciated in any country, the demand for them will speedily come, but as yet this demand is but a small factor of what it should be in our trade with Britain.

The French are quicker to see what a labor-saving tool can do, but they also sooner imitate and change it to their peculiar needs. On the whole it is questionable if France is as promising a field for many American-made mechanical goods as many other countries. This is true of Switzerland, in a less questionable sense. It is not presumable that the German nations, with their intense race prejudices and their imitative methods of manufacture, can be the markets for any American line of goods for a great length of time. Their tariff is high and their patent system requires that alien patentees shall construct within the territory covered by the grant. The Scandinavian people and the Russians are good customers for good qualities of well-designed mechanical novelties, and these people are friendly to this country, and are intelligent and without national prejudices or favoritisms.

The Latin races are poor *per capita*, and while they would be good buyers of novelties if they had the means, there are not enough prosperous people among them in proportion to the population to make these countries very profitable markets. Asiatic people are miserably poor, and American prices are not comparable with their standards of value in any sense. Hence, there is seldom a profit in selling them goods for cash, but sometimes those who know how can make enormous profits in buying from or trading with them.

The South American countries are probably the best general markets now open to our goods, because the people there do not manufacture engineering products themselves, but they produce immense quantities of raw materials of the most valuable character and qualities. These materials give them means to buy, and they buy freely and pay good prices for rather coarse goods. One fact in connection with South American trade is that in the general absence of railways and of good roads most goods must be packed to be carried on the backs of mules, and therefore each package for shipment to some places far inland must not weigh more than a certain amount, which varies with differing goods and kinds of packages.

On the whole the outlook for profitable markets outside the United States for goods made within is quite good. Manufacturers must not expect, however, that our home conditions will prevail everywhere, for in every place the tastes are different, and the manner of doing business is different. For instance, there is not in the whole world another "one-price" country than this, in any sense, and it is not always "one price" here. In other countries the seller fixes a price in his mind below which he will not go; then he asks more than double for it and takes all that he can get. A "one-price" concern in such a country would be a novelty indeed, and the buying of an article by a native from such a concern would be a tame and charmless affair; in fact he would not know how to do it.

There are a few other points which our exporting manufacturers must take into consideration if they seek to successfully occupy new markets. Firstly, a demand must be made for the goods if they are novel in character, and if they are but of superior quality or of greater cheapness, these qualities also must be diligently shown and repeatedly emphasized. This will take time, enterprise, and courage, for old ideas are not rooted out in one day, neither do new ones take root and bear fruit at once. Secondly, the conditions of life in each country will have to be studied; thus it is but seldom that a cargo of warming-pans is a paying exportation to the West Indies. It is true that an article sometimes is of benefit to people everywhere, and if no demand exists such demand can be made by educating the people up to it. But often much effort is wasted in trying to work up trade where the tastes and habits of a people are foreign to it. For instance, there manifestly would be but little profit in exporting modern agricultural implements to Newfoundland, wine into Egypt or Turkey, barbed wire to Hindustan, type-writers to China, or clothes-wringers to Kaffirland. Thirdly, where the goods are such as the people need, the effort to introduce them must be intelligently made. There are but few machines that do not require modifications to suit different countries. Thus treadle sewing-machines do not find ready sale in South America, and hand-operated machines must be made to suit the trade in the countries that are situated in that grand division, and thus these same machines exported to France to make clothing must be adapted to sew heavy corduroy cloth without fulling the side of the goods nearest the feed.

The sewing-machine is the grand American exploit in machine

design and manufacture, and in its introduction to other countries. It makes no difference who, before our American inventors, first tried to make such machines; they were perfected here, and from here the missionaries went who converted the earth to a knowledge and appreciation of their merits. In most lands there was no demand for this machine, and no expectation of its appearance. So the missionaries were obliged first to create the idea that sewing by hand was a hardship, and that a saving in time could be effected by the new device. Then they were obliged to prove that the saving was worth the cost, and lastly they had to show the poor how machines could be bought without much ready money, while the buyer could obtain the machine at once and use it as a help to pay its cost. All these things have been accomplished by having goods that the sellers had confidence in, by enterprise in extending their markets to the boundaries of the earth, by showing their customers how they can pay for a machine which they have not the money to buy, and by keeping faith with their customers to the uttermost. Hence the sewing-machine is the one common omnipresent piece of machinery in the homes of all classes of people everywhere in the whole world. It is the one touch of art that "makes the whole world kin," for it serves all manner of persons alike in all manner of circumstances and in all manner of situaations. The magnitude of this sewing-machine business is wellnigh inconceivable. One concern makes about three-quarters of a million of machines each year. It owns and equips an agency in every town on earth having any pretensions to population. It employs 60,000 men and women and owns thousands of horses and wagons, and, if an envelope were addressed to this company and directed to any town of 5000 people on the civilized globe, it would find a salaried representative of that company at the place specified to receive it.

Now while it is not probable that many things can approach the sewing-machine as a mechanical and commercial success, still the same facts of mechanical excellence, the same spirit of business push and enterprise, the same endeavor to supply a means to the buyer to enable him to pay for his purchase, and the same honesty and the fair-dealing spirit to create and maintain the trust and respect of all people dealt with, will surely meet all the success the goods deserve.

The improvements in means for transporting goods to remote inland settlements which are going on constantly and are being

developed in an accelerated ratio will assist foreign commerce in a number of ways. These improvements will require locomotives and rails if they are railroads, and if they are steamers for the idle waterways there will be engines required for them and in many cases the complete craft will be ordered to be built. I am informed that the great Magdalena river, in Colombia, has lines of regular steamers of first-class make and equipment, and that some of these steamers were made in the United States, sent out in sections, and put together on that river. These improvements in transportation, however, are calculated to benefit American manufacturers more as a means to carry goods to customers than as articles or material in themselves to be manufactured and sold. Asia, Africa, and South America are thus being opened to receive manufactured goods, and this extension to possible markets inland is large and varied. The traffic with Africa which has been opened by recent explorations will consume great quantities of coarse goods serviceable to the development of the natives and to the use of settlers in that immense territory. American lumbering machinery of a portable character, gold-mining machinery, the simpler kinds of farm machinery, as well as water- and wind-operated motors of simple construction and slight cost, will be in probable demand. Tools and methods to prepare and transport the cabinet woods of South America alone to the navigable waters might well occupy some of the talent and industry of one large American city, while the profits from this industry would enrich a whole State.

Asia promises to be the market for great quantities of mining machinery, and, because American devices of this character have been developed to the greatest of perfection, we should occupy this market. Japan has put herself abreast of the nineteenth century and is quickly fitting herself for the enjoyment of its mechanical characteristics. America is not yet getting her share of the benefits to be derived from supplying that great country with equipment to facilitate the change from the old forms of the arts to the new. Hence there is here a field to be occupied which is filled with a people anxious to accept as superior the arts of our civilization and willing to buy all the tools and instruction their means afford. They ask no specialties, but take what is here found to be best. They do not demand that we shall adapt our goods to their peculiarities, but volunteer to adapt themselves to our tools. At this distance this seems an ideal market.

INDUSTRIAL DEVELOPMENT OF THE SOUTH.

By Richard H. Edmonds.

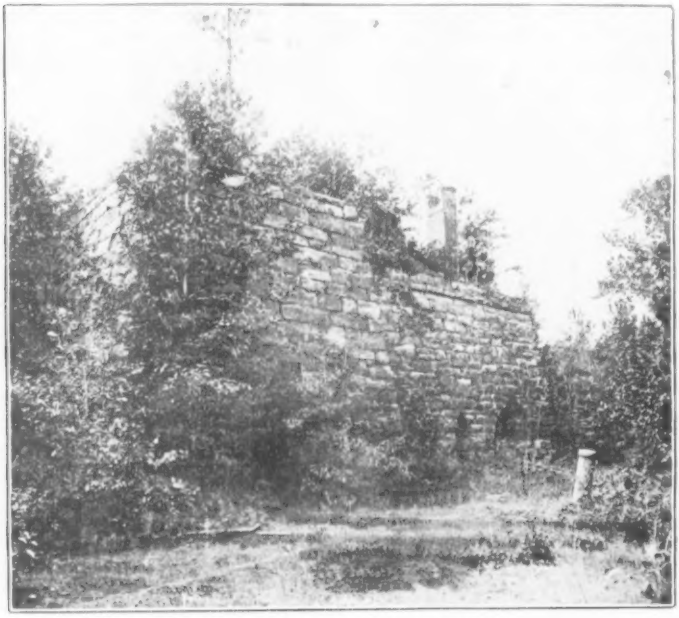
IV.—THE PROMISE OF THE FUTURE.

WITH an increase of less than 25 per cent. in its population since 1880, the South has increased its annual output of agricultural and manufactured products nearly 100 per cent. In 1880 the value of its chief agricultural products was $749,000,000, and of its manufactured products $457,000,000, a total of $1,206,000,000. Now, agriculture yields to the South from 950 to 1000 millions a year, and, while the delay of the Census reports makes exact figures unobtainable, it is quite certain that its industries of all kinds are producing at least 1200 millions a year, a total of about $2,150,000,000. In other words, the South is now producing in agriculture, manufactures, and mining about $1,000,000,000 a year in excess of what it produced in 1880, and every year shows a large growth in this excess. Again, in 1880, the average value of the South's agricultural and manufactured products was $73 per capita; in 1890, by reason of enlarged opportunities for work provided by the South's industrial development, the average was $109 per capita, a gain in productive capacity per capita of 50 per cent. Ten years ago the South was essentially an agricultural country, without diversity of employment for its people. Without the opportunity to find any occupation except in agriculture, which only required work during a part of the year, the South's potentiality in labor was not more than half utilized. The sum of all the work accomplished was not equal to the aggregate that could have been done by one half of the population of that section if steadily employed.

Every new furnace, every cotton or woolen mill, every saw mill built, every mine opened, every new town development made, broadened the market for labor and furnished employment to people hitherto of necessity idlers during a large part of the time. Notwithstanding the great expansion of industrial interests during the last few years, there is still a large amount of surplus labor in the South. With the growth of manufacturing and the increase in urban population, the opportunities for regular employment for both men and women will be constantly enlarged, and the average per capita of pro-

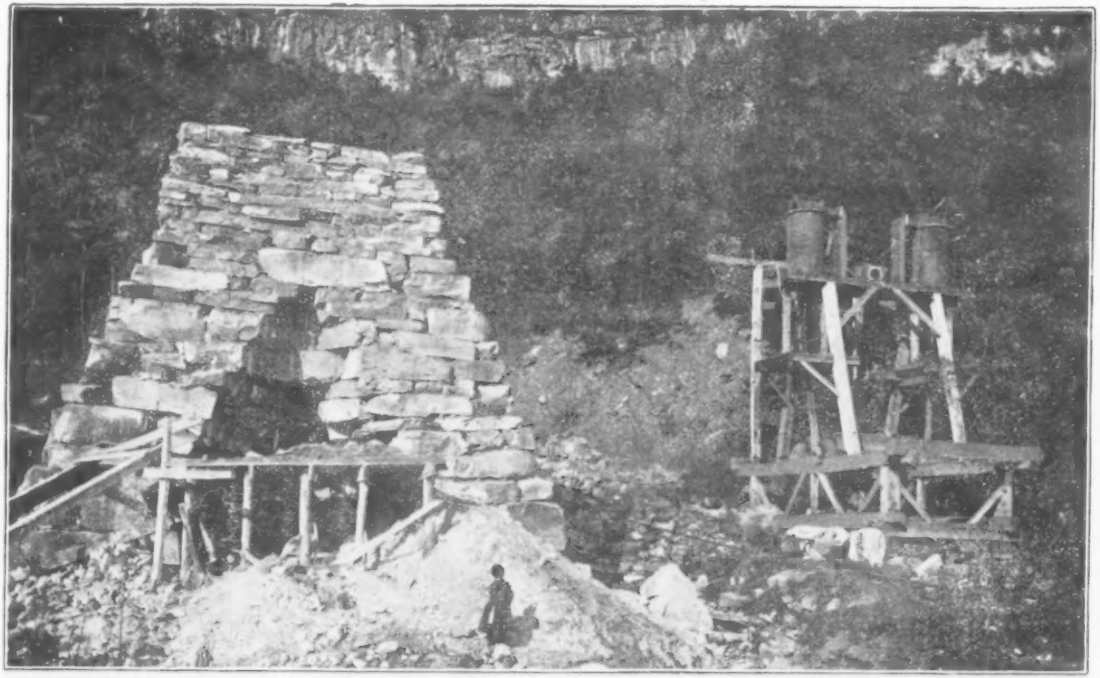
ductive work performed by the people of that section will gradually approach that of New England, where the diversity and magnitude of business interests afford profitable employment for everybody. The greatness of the change wrought since 1880, however, can be realized simply by remembering that the South is now annually turning out $1,000,000,000 worth more of agricultural and manufactured products than it did ten years ago. There is no possible danger of any decline; on the contrary, this increase goes on steadily, and the decade ending with 1900 will show an aggregate production in the South of at least $10,000,000,000 in excess of the production in the decade from 1880 to 1890.

In the preceding paper some illustrations of Southern advancement were pointed out in the rapid growth of a number of towns and cities, and the brief statement of facts just given shows what the sum of this increase has been. A presentation in detail of a summary of the growth in the value of property and the increase



A RELIC OF EARLY IRON-MAKING IN ALABAMA.

[Ruins of a furnace built in 1815 and destroyed during the war. On this site iron was first forged in Alabama in 1826, on Rhodes creek, Tuscaloosa county.]



RUINS OF AN OLD IRON FURNACE, CUMBERLAND GAP, NEAR MIDDLESBOROUGH, KENTUCKY.

[A relic of iron-making in ante-bellum days. Now used for burning lime.]

in the extent of leading industries within the decade from 1881 to 1891, as in the following table, may be of interest :

	1881.	1891.
Assessed value of property	$2,913,436,095	$4,816,396,896
Assessed value of property per capita	$187	$271
Railroad mileage	23,811	44,805
Total receipts, Southern railroads	$60,228,000	$140,088,000
Aggregate value of agricultural and manufactured products	$1,206,000,000	$2,150,000,000
Average value of agricultural and manufactured products per capita	$73	$109
Yield of cotton, bales	5,456,000	9,035,000
Number of cotton mills	161	356
Number of spindles in cotton-mills	667,854	2,149,020
Yield of grain, bushels	404,301,000	672,459,000
Value of chief agricultural products	$749,000,000	$926,000,000
Coal mined, tons	6,000,000	23,000,000
Pig iron produced, tons	451,540	1,914,000
Phosphate rock, tons	266,000	*650,000
Capital invested in cotton-seed oil mills	$3,504,000	*$30,000,000
Number of national banks	223	640
Capital of national banks	$45,010,000	$99,905,405
Exports from Southern ports	$257,535,000	$349,801,000

*Estimated.

The South's gain in population from 1881 to 1891 was only about 20 per cent. With only this increase in population, which should be remembered in order to appreciate what that section has accomplished, the South increased its grain production from 404 million bushels in 1881 to 672 million bushels in 1891,—a gain of 66 per cent.; its cotton crop increased from 5½ million bales to 9 million bales, or 64 per cent. It practically created in that period its early-vegetable and fruit business for northern markets, which now yields upward of 50 million dollars a year, and largely added to its cotton, rice, and sugar crops. Its pig-iron production, which was 451,000 tons in 1881, was 1,914,000 tons in 1891; its coal output rose from 6,000,000 tons to 23,000,000 tons; its cotton spindles from 667,000 to 2,150,000; its cotton-seed oil industry from an investment of $3,500,000 to about $30,000,000; its railroad mileage from 23,811 miles to 44,805 miles, a gain of 87 per cent.; in 1881 the value of its foreign exports was $257,535,000, and in 1891 $349,801,000, a gain of $92,266,000, or 36 per cent., against a total gain of $44,700,000, or 7.7 per cent. at all United States ports outside of the South; it largely more than doubled its

SITE OF THE PRESENT WATTS IRON AND STEEL PLANT, MIDDLESBOROUGH, KENTUCKY, IN 1889.

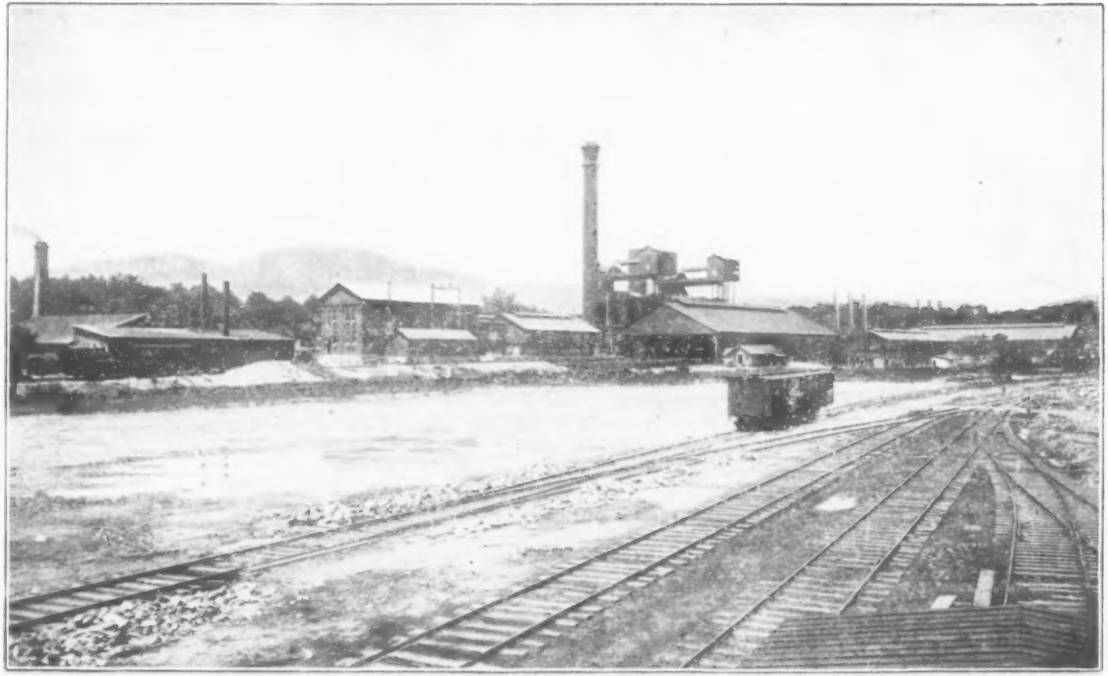
banking business, increasing the number of its national banks from 223 to 640, and their aggregate capital from $45,000,000 to $99,900,000; it added to the assessed value of its property nearly $2,000,000,000, or 65 per cent., making the average assessment per capita in 1891 $271 against $187 in 1880.

Census Bulletins Nos. 149 and 161 give the railway statistics of Virginia, West Virginia, North and South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, and Kentucky, which are classed as Groups 4 and 5. Bulletin 155 gives the same information for Illinois, the Northern Peninsula of Michigan, Min-

MARY PRATT FURNACE, BIRMINGHAM, ALABAMA.

nesota, Wisconsin, Iowa, North and South Dakota, and Missouri, classed as Group 6. This group embraces the most prosperous and progressive States of the West. It takes in the grain States, the States which have had the heaviest immigration, the great iron-ore region of Michigan, and also Illinois, one of the largest manufacturing States in the Union. Certainly these States should show a far more rapid increase in railroad business than the Southern States. Do they?

These figures show a wonderful difference in favor of the South



WATTS IRON AND STEEL PLANT, MIDDLESBOROUGH, KENTUCKY.

[More than $2,000,000 has been spent on this plant by a syndicate of English iron and steel makers,—including two 150-ton furnaces and a 750-ton steel plant. It is expected that it will be in operation this winter.]

between the railroad growth of the two sections. The volume of business, both passenger and freight, has increased far more rapidly on Southern roads than on Western, and at the same time the average rates per ton and per passenger per mile have been decreased to a far greater extent on the former than on the latter.

Taking the Census figures we have the following :

Details.	1890.	1880.	Increase.	Percentage of Increase.
Railroad Mileage :				
Southern States.....	24,955	13,227	11,728	89
Western States.....	41,299	23,588	17,711	75
Passengers Carried :				
Southern States.....	30,061,297	6,395,074	23,666,223	369
Western States.....	61,726,854	22,824,192	38,902,662	168
Freight moved, tons :				
Southern States.....	61,771,929	17,759,441	44,012,488	247
Western States.....	91,923,892	42,650,558	49,273,334	115
Earnings from passengers :				
Southern States.....	$28,959,091	$12,819,137	$16,139,954	125
Western States.....	$56,149,625	$30,383,155	$25,766,470	84
Earnings from freight :				
Southern States.....	$70,108,557	$33,068,057	$37,040,500	112
Western States.....	$138,517,533	$92,140,792	$46,376,741	50
Total earnings :				
Southern States.....	$103,061,218	$46,957,460	$57,103,758	122
Western States.....	$206,286,979	$126,710,326	$79,576,653	62
Average receipts per mile per passenger, cents :			Decrease	Percentage
Southern States.....	2.291	3.194	0.903	28
Western States.....	2.338	2.541	0.203	8
Average receipts per mile per ton of freight, cents :				
Southern States.....	0.926	1.691	0.765	45
Western States.....	1.018	1.369	0.359	35

The most interesting feature of these figures is the exhibit of the growth of manufactures in every part of the South. It is generally known that Atlanta, Louisville, Baltimore, and Augusta have greatly increased their manufacturing interests ; but it is not so widely known that Richmond, Norfolk, Charleston, Memphis, New Orleans, and Savannah have, during the last ten years, doubled, and in some cases quadrupled the capital invested in their factories.

The Census Bulletins on the manufacturing statistics of the leading cities of the country give the following figures as to the growth of some of the cities of the South :

OLD SCREW COTTON PRESS IN OPERATION.

MANUFACTURING STATISTICS OF SOUTHERN CITIES.

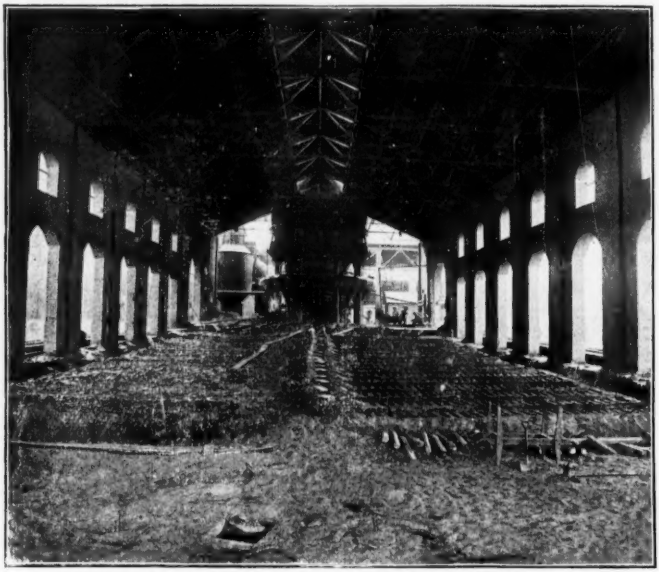
CITIES.	Population.		Capital.		Value of Products	
	1880.	1890.	1880.	1890.	1880.	1890.
Richmond	66,600	81,388	$ 6,884,386	$15,698,897	$20,790,106	$25,891,569
Mobile	29,132	31,076	525,708	1,450,373	1,335,579	2,872,017
Wheeling	30,737	34,522	4,868,288	7,223,027	9,259,844	11,279,541
Norfolk	21,966	34,871	570,276	3,120,819	1,455,987	4,034,263
Atlanta	37,409	65,533	2,468,456	7,894,870	4,861,727	11,239,591
Charleston	49,984	54,955	1,718,300	7,300,150	2,732,590	8,892,860
Memphis	33,592	64,495	2,313,975	7,985,888	4,413,422	11,800,455
Nashville	43,350	76,168	3,892,380	9,166,626	8,597,278	13,673,730
Augusta	21,891	33,300	2,069,275	7,075,996	3,139,029	8,631,888
New Orleans	216,090	242,039	8,565,303	20,695,794	18,808,096	34,770,519
Savannah	30,709	43,189	1,102,970	2,977,459	3,306,297	4,467,688
Baltimore	332,313	434,439	38,586,773	82,526,344	78,417,304	140,401,026
Louisville	123,758	161,129	21,767,013	30,542,947	35,423,203	45,452,209

The regeneration of the South—its redemption from the chaos and poverty which followed the war and which continued for ten years or more after that great struggle—probably has no equal in the world's history. The statistics summing up the progress of the last decade tell something of what was accomplished during that period, and give some hint of the vast possibilities of the future. Thus far only the foundation work has been done. The financial success of Southern iron-making through the severe depressions that have fully demonstrated its right of living because of the "survival of the fittest"; the wonderful increase in cotton-manufacturing, extending to a gradual advance in the production of the finer goods; the steady growth of diversified iron industries, such as locomotive-building, iron and steel shipyards, machine- and engine-shops, pipe foundries, and similar enterprises,—all unite to give the assurance of strength and permanency to the

SCENE ON JAMES S. RICHARDSON'S MARCELLA COTTON PLANTATION, HOLMES COUNTY, MISSISSIPPI.

South's rapid industrial advance in the future. When the progress already made is contrasted with the possibilities given this section by its rich endowment of natural resources and advantages in soil, minerals, timber, climate, accessibility and cheapness of utilization of raw materials, etc., it will be seen that Southern development has scarcely commenced.

The work of the Norfolk and Western and Chesapeake and Ohio railroads in the development of their enormous coal traffic, and in the establishment of the immense coal-shipping interests at Norfolk and Newport News, now reaching an aggregate of 2,500,000 tons

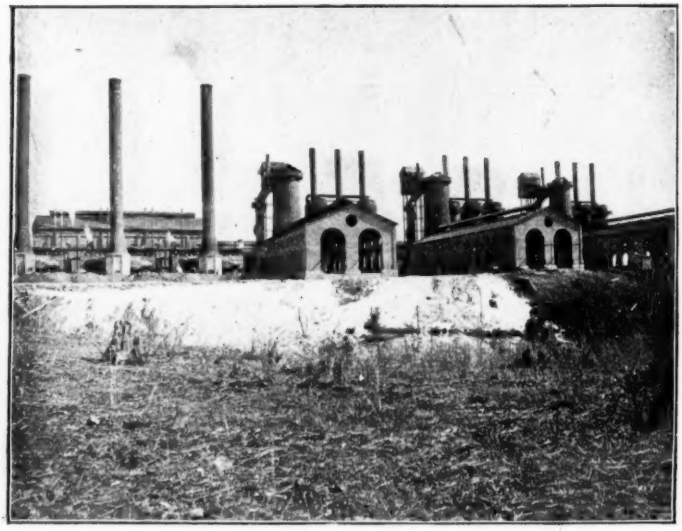


PIG BED AND CAST HOUSE, ENSLEY FURNACE, ALABAMA.

per annum, commands universal admiration; but we are apt to forget that this has all been done within less than ten years, that the development of the territory opened up by these roads has in reality but just commenced, and that the progress of the next ten years must far surpass that of the last ten. This point is emphasized by a contract made last November by the Norfolk and Western railroad to deliver 3000 tons of coal a day at Toledo, which is the beginning of a great Western coal business for this road. Looking at the great results accomplished by the Louisville and Nashville

ENSLEY FURNACES, ENSLEY, ALABAMA.

EUREKA FURNACES AT OXMOOR, ALABAMA.



THREE FURNACES AT SHEFFIELD, ALABAMA.

railroad, and the coal and iron traffic which it handles, it is difficult to realize that in 1880 Alabama only made 77,000 tons of iron and mined less than 350,000 tons of coal. We forget that ten years ago Birmingham had scarcely 4000 people; that for five years later Bessemer was unthought of and its site a forest; that Anniston was simply a furnace town of probably 1000 inhabitants; that Roanoke was an almost unknown way station of 600 people; that Middlesborough came into being less than four years ago; that Newport News gave no promise of its present importance; that Chattanooga and Knoxville, Atlanta, Norfolk, Dallas, Fort Worth, and dozens of other places of present national prominence were, with a few exceptions, simply fairly prosperous trading centers. And yet how great can the growth of the future be without overdoing Southern industrial development.

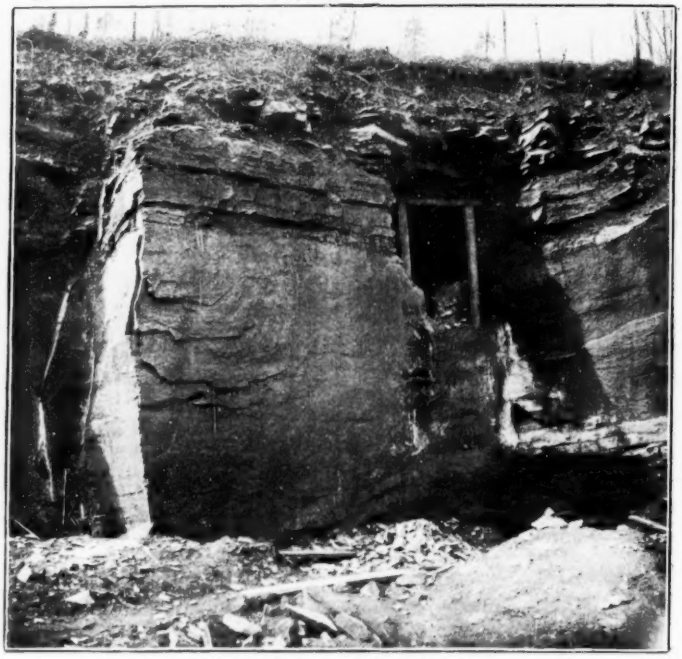
Here is a region of unequaled natural resources, of coal and iron in inexhaustible quantities, in close proximity and at low cost of production, of great timber wealth, of soil adapted to every branch of agriculture; in fact, a combination for the creation of wealth greater than any other equal area in the world possesses. Its population is still sparse, its manufacturing and mining in-

terests still in their infancy, its towns and cities less numerous than in any other part of the country. With all the industrial advance of the last ten years, the whole South does not yet equal the one State of Pennsylvania in the valve of its manufactured products. West Virginia alone has far more coal than Pennsylvania, its coal area exceeding even Great Britain's; it has many times as much standing timber as Pennsylvania; and it can develop its industrial interests until they exceed in value the present aggregate of the fourteen Southern States and still not be more crowded than is Pennsylvania. What is true of West Virginia is true of other Southern States. Some years ago Colonel A. K. McClure, of Philadelphia, said of Alabama: "There is not a source of mineral wealth in Pennsylvania, excepting only our oil product, that is not found in Alabama in equal or greater abundance, with the matchless advantages of climate, of easier and cheaper production, and of vastly cheaper transportation. Nature's great gifts to Pennsylvania have been not only liberally supplemented in Alabama, but to them have been added every possible advantage for their cheap development and delivery to the markets of the world." Alabama is 6600 square miles larger than Pennsyl-

TANNEHILL ORE MINE, IN ALABAMA.

vania. Every manufacturing enterprise now in existence from Mason and Dixon's line to the Rio Grande might be located in Alabama, and still that State, with far greater resources than Pennsylvania, would not equal it in its present industrial product.

There is no danger, therefore, of Southern development reaching the limit of profitable advancement. Many thousands of miles of new railroads can be wisely built into virgin mineral and timber regions, which will afford paying traffic from the day the first train



IRON ORE, EUREKA VEIN NO. 2, ALABAMA.

rolls over them, and also into settled parts of the South now without transportation facilities. The growth of coal production from 6,000,000 to 23,000,000 tons in one decade can be duplicated for many decades, and a market be found for it. Producing nearly two-thirds of the world's cotton supply—9,000,000 out of a total of 15,000,000 bales—but having only 2,000,000 out of a total of over 80,000,000 spindles in the world, the South has room for multiplying indefinitely the increase already made in cotton manufacturing.

HOW TO CHOOSE AN ARCHITECT.

By Bernard McEvoy.

IT is comparatively easy for a private proprietor to choose an architect to design and carry out any building he has determined to erect. It is a much simpler matter for a man to make up his own mind than to help to make up other people's minds. In the present article reference will be made chiefly to the selection of architects for public works such as churches, schools, halls, libraries, and executive or municipal buildings. The choice of an architect for a work of this kind is usually entrusted to a committee, few of the members of which have any special fitness for the work that they are called upon to do. No one who has had anything to do with building committees can have failed to be struck by the want of judgment and the child-like ignorance displayed by many of the members. Pleased with surface attractions and fond of pretty pictures with a fondness that is almost infantile, the simple members of building committees are frequently the victims of so-called architects, who, though they may be able to produce attractive drawings, lack every other essential characteristic and quality of the true and capable designer of buildings. As a consequence, edifices are continually being erected which sin not only against the canons of taste but against the laws of nature : they degrade the esthetic perception of the public, and it is only by good luck that they do not tumble down.

Then again, building committees are too often at the mercy of tricky schemers and "fakers." There are so-called architects who lay themselves out to delude this class of clients. The writer well remembers an instance of this kind, which may be here narrated. In the course of a visit to a friend living in a city that may be called Boardville, his host happened to mention that he was a member of a church-building committee, and one evening he begged to be excused in order to attend a committee meeting. A great New York architect was coming to submit plans for the new church, and the committeemen were looking forward to his visit with much interest. My host returned home radiant and delighted with the New Yorker. The latter had submitted a design which apparently combined picturesqueness of detail with grandeur of conception,—

the greatest possible amount of beauty and the minimum of cost.

"He's a fine fellow," said my host; "you should hear him talk. He has the building at his finger-ends and speaks of the smallest detail as though he loved it. Such undoubted ability! such mastery! He has planned a church that will be the gem of the city, and after looking at his drawings one can understand one very striking remark he made."

"What was that?"

"Oh, he said it had been the dream of his life to build a church like that,—the dream of his life. I like to see a man so earnest and enthusiastic. I am going to vote for him, and so are more than half of the rest of the committee."

So the enthusiastic architect was chosen, and, as it transpired, he maintained his hold for a considerable time on the reverential respect of the committee. It was only when it was found that the lowest builder's estimate that could be obtained for the building of the church was 30 per cent. more than the architect's estimate, and also that after the work had been begun very important changes in construction had to be resorted to in order to make the building safe, that this genius began to be worshipped with a less adoring homage. Moreover, the church was found to look very much less imposing in reality than it had in the drawings, in which advantage had been taken of every trick of draughtsmanship and shading to produce an effective *tout ensemble*. The committee had expected a masterpiece and they got a comparatively common-place church, which had to be strengthened with iron rods and girders to keep it upright.

Two years later the writer was invited to pay a visit to a relative at, we will say, Grandejoue. Strangely enough his host upon this occasion was also a member of a church-building committee. He too was absent one evening at a committee meeting, and on his return the writer was surprised to find that the identical New York architect before mentioned had been interviewing the committee.

"Well, does the architect meet your views?" said the visitor.

"Exactly. He is a very fine fellow; really a remarkable man," said the host impressively.

"Indeed?"

"Yes. Such mastery of his subject. You should hear him! He is a thorough genius. He says it has been the dream of his life to build a church like the one he proposes, but he has never had the opportunity until now."

Of course it was the hero of Broadville.

He had quite taken the committee captive by his pretty drawings and his eloquent talk. He was, in fact, a clever drummer who could draw. He understood next to nothing of scientific construction, rarely made a calculation as to strains and stresses, put in deep shadows in his drawings where there was no varied outline in the profile of the building itself to justify it, and drew attractive figures in the foreground which by their ridiculously small comparative size elevated the fictitious edifice on paper into grand proportions. When he got hold of a building committee, he conquered them by his clever readiness and flattered them in a way that his exquisite perception of character rendered possible. He was a swindler of the deepest dye, and it must be confessed with regret that he was but the representative of a class. If all professing architects were able and conscientious, it would not be necessary to write any words of advice relative to the choosing of an efficient practitioner.

When it has been determined by a public body to erect a new building, we will say a school or an asylum or a city hall, it is usual to throw open the designing of it to competition. The most absurd ideas are entertained by some people as to the conditions on which such a competition should be conducted. For instance, it is not long since the board of a collegiate school advertised for complete plans and specifications of a projected large institution to be sent in *within a fortnight.* Apparently they imagined that the architects were all waiting with paper stretched on their drawing boards and with their T squares ready, and that they would immediately start on the plans like runners at a foot-race. Members of committees are apt to think that they confer a great favor on architects by allowing them to compete for their work, whereas, as a rule, the favor lies the other way. Architects generally enter competitions knowing full well that the trouble and expense which they will incur is not at all likely to be rewarded by the coveted prize. A competition is a lottery in every sense of the word. There is first the very likely possibility that the competitor may be surpassed by somebody else, and there is also the likelihood that those chosen to decide the relative positions of the competitors may be incompetent, biassed, or prejudiced. Instead of being possessed of a judicial mind, capable of weighing with painstaking effort every point for or against each design sent in, they may be influenced in their decision by some trivial novelty in plan.

It must be allowed, however, that a competition gives to many a young architect a chance he would not otherwise secure. A beginner entering upon his professional life is not as a rule overburdened with commissions, and he has, consequently, the necessary time for the thorough preparation of a set of competitive drawings. He is also, or should be, ambitious to get a commission which will bring him before the public as a competent and capable man. A contest with those of greater experience or with others in the same position as himself is of itself a sufficient inducement for a young man of energy and ambition. He can give more time and study to the problems before him than the busy man with a large practise, who, if he enters a competition, will probably sketch out a rough plan and leave his employés to do the best they can with it, giving them such general supervision as he may be able to supply without neglecting interests of assured, and therefore of greater importance.

That the best design submitted is not adopted is a matter of frequent occurrence, and it also often happens that a poorer design is erected as the result of a competition than would have been the case if the employing body had used ordinary care in selecting an architect and had consulted with him from time to time so as to give him definite instructions as to what they wanted. Still, competitions may sometimes be of great service, if properly conducted, in the producing of a superior design or in the bringing forward of a man of ability and promise who would not otherwise have been made known, or who would have had to wait many years for promotion to a position to which he is entitled and in which a happy opportunity places him at a bound.

It is exceedingly difficult, however, to arrange a competition which shall at one and the same time be fair to competing architects and result in obtaining the best possible building for the purpose required. To begin with, the committee are not certain as to what they want to build. Only a dim idea of the public hall, the school, or the church which they are banded together to produce floats through the minds of most of the members. Then again, they are as a rule not acquainted with the way in which a competition should be arranged and the regulations that should strictly govern it so that the causes of offence and discontent which are inevitable in such contests may be as few as possible. Lastly they are generally unable, unless properly instructed, to decide on the respective merits of the designs sent in.

In order to get over these obstacles it is perhaps the best way to select an architect who shall be competent to act as an expert and judge, and for the committee to regard themselves for the time being as the jury. They may say of course that if they are able to agree upon an architect at all, the better plan would be to entrust him with the erection of the building, without bothering about a competition, and in nine cases out of ten this would undoubtedly be true. The competitive plan is however usually regarded with favor, and it may be well to indicate the means whereby it may be most satisfactorily conducted.

Let the committee, therefore, the size of which may vary according to the importance of the building (I have known a committee of twelve to build a $100,000 church very well) elect an architect of proved ability—a man of experience and solid acquirements—to act as their guide, counsellor, and friend. Let them at repeated conferences give him, with as much detail as possible, what they think they want. His experience will no doubt enable him to suggest things to them which unaided they would never have thought of. After a few interviews he will be in possession of their ideas and will be able to frame full instructions for the competing architects. The uses and requirements of the proposed building should be fully explained. It will also be his duty to lay down a scheme of conditions under which the competition shall be strictly conducted. The following set of conditions prepared by Mr. S. J. Curry, of Toronto, Canada, appear to me to combine every requisite and workable feature :

PROPOSED NEW CITY HALL AND MARKET AT B————.

1. It is proposed to erect a City Hall and market on A—— street, B————. The site has —— feet frontage and is —— feet deep. [See annexed sketch plan.]

2. The entire cost of the buildings is not to exceed $——.

3. The following accommodation is to be provided : [Here follow full particulars.]

4. Competitors are invited to send in the following drawings. They are to be accompanied by a memorandum, type-written, explaining any points in the design not obvious from an inspection of the drawings, and also describing the nature and quality of the materials proposed to be used in the erection of the buildings :—

a Block-plan of site showing position of buildings.

b. Plans of different floors, including the basement.

c. Four elevations.

d. Transverse and longitudinal sections of the principal building and one section of the minor buildings.

e. One sheet of details of the exterior and one sheet of details of the interior of the principal building.

f. One perspective showing the buildings placed upon the site as suggested by the competitor.

5. The general drawings are to be made to a scale of $\frac{1}{8}$ in. to a foot and finished in line with Indian ink. The detail drawings are to be prepared to a scale of $\frac{1}{4}$ in. to a foot.

6. There is to be no brush work except in blacking in the windows and the sectional portions of the plans and sections. Color in flat brush work may be used in showing the materials on the sheet of details. The lettering and figuring is to be plain and simple, and is to be confined to the names and sections of the rooms, written in the middle of each without explanatory notes, which are to be placed by themselves in the separate memorandum. The number of square feet in each room is to be given as well as its lineal dimensions. These drawings are to be made on good white paper.

7. The perspective may be in ink or sepia only without coloring, or it may be etched, but without any unnecessary accessories such as sky or figures. It is to be set up from a sixteenth of an inch scale plan.

8. The sanitary arrangements, heating, and ventilation are to be carefully studied and clearly shown on the drawings or on separate drawings prepared for that purpose, as may be preferred. They are also to be fully described in the accompanying type-written memorandum.

9. All designs received in competition will be submitted to a competent non-competing architect who in conjunction with the committee having the work in hand shall examine and advise as to their respective merits, and decide which design in their opinion should be placed first, the author of which will then be entrusted with the execution of the work.

10. The author of the second best design will receive $——; the author of the design considered to rank next to that will receive $——.

11. All drawings shall have the *nom de plume* of their author clearly marked in their right hand top corner and shall be accompanied by a sealed envelope bearing on the outside the same "nom de plume" and on the inside the full name and address of the author.

12. All designs must be sent in to the City Clerk of B——— not later than —— 1893, and marked "Plans for City Hall and Market."

13. All drawings will be returned to their respective authors carefully packed and prepaid.

14. Any information which the consulting architect and assessor may see fit to communicate to competitors in answer to any inquiry will be in print and communicated to all the rest. Such questions cannot be received after ——, 1893.

15. Drawings will be excluded from the competition at once:—

a. If sent in later than the period named (accidents in transit excepted).

b. If in violation of any of these instructions.

c. If they do not provide the accommodation called for.

d. If they exceed the limits of the site.

e. If on the face of them they grossly exceed the limit of cost prescribed.

A comprehensive schedule of instructions as to requirements and a scheme of conditions similar to the foregoing should enable the architects who respond to the committee's advertisement for

competitors to start fair. A proper time having elapsed for the making and sending in of drawings, the next thing will be to decide which of them most nearly comes up to the ideal of convenience, beauty, and substantiality which the committee have set before themselves. It will to this end be the duty of the expert and judge, after due study of the respective drawings, to give the committee the benefit of his counsel and advice. They can of course, if they like, empower their expert to choose for them, but not only does this place the expert in an invidious position, but it will be likely to create trouble among those who are not fortunate enough to secure the coveted commission. I am aware that the plan I favor is open to the objection that it allows a wire-pulling member of the committee to get in his nefarious work on behalf of a favorite competitor. It is too frequently the case that a competing architect gets a commission through undue influence rather than because his work is excellent. But on the whole, and given a conscientious committee, the jury plan is the fairer. If the expert judge properly direct them, they will have but little difficulty in deciding on the best design. The jury should set their faces sternly from the commencement against any tampering with the anonymity of the competitors. Let them as far as possible base their decision on the merits of the respective designs alone. A majority of votes should settle the matter, and the decision when arrived at should be loyally adhered to by every member.

GEOLOGY AND THE MISSISSIPPI PROBLEM.

By A Southern Engineer.

THE controversy maintained in the pages of this Magazine on the expediency of dike-building on the Mississippi is of interest for two reasons: first, because it is a large subject involving the well-being of a broad section of the country, and, secondly, because it is more strictly a scientific than technical subject, comprehending in its thorough discussion all those theories of alluvial formations and the modifications of continents that have been demonstrated by geologists.

Consistently with natural phenomena as observed in the changing faces of mountain-ranges, rocks, valleys, plains, and the silt or sedimentary deposits seen along the shore and at the mouths or off the mouths of rivers, we cannot speak of the completed bed of a river in the terms selected by Chief Engineer Starling in one of the articles under consideration. In accordance with geological law a river can never be completed until the water itself has disappeared, and the channel, filled in by the winds, the washings of hillsides, or by the plow, has risen to the level of the adjacent land. But to show the truth of this statement it will be necessary to analyze the processes of nature as they have been observed by geologists in tracing different geological periods.

We need not, however, go back to the beginning. Our purpose will be best subserved by finding the force most effectively at work at the present time. It will concern us little to know whether the upheaval of continents was due to those Plutonic agencies which the earlier geologists were wont to invoke, or whether they were crushed into being by the contraction of the earth's crust, as it has been more recently taught. Plutonic agencies may be still at work; but their performances are local. Seismic agencies may sometimes disturb half a continent; but their energies directly subside, and the total result of their effort is comparatively small. There is an agent, however, ceaselessly at work observing neither nights nor Sundays, and never even changing its aspect unless with a purpose of changing its mode of activity. This agent is water, beyond comparison the most potent agent extant. But lest it be suspected that its power is overstated, let us reinforce a little here

by testimony of the most scientific character. The quotations that follow are from Professor Geikie:

Of all the terrestrial agencies by which the surface of the earth is modified by far the most important is water. . . . . The substance which we term water exists in three well known forms: (1) gaseous, as invisible vapor; (2) liquid, as water; and (3) solid, as ice. . . . . By the sun's heat vast quantities of vapor are continually raised from the surface of the seas, rivers, lakes, snow-fields, and glaciers of the world. . . . . As the vapor is largely raised from the ocean surface, so in great measure it falls back again into the ocean. A considerable proportion, however, descends upon the land. Upon the higher elevations it falls as snow, and gathers there into snow-fields, which, by means of glaciers, send their drainage downward towards the valleys and plains. Elsewhere it falls chiefly as rain, some of which sinks underground to gush forth again as springs, while the rest pours down the slopes of the lands, feeding brooks and torrents, which, swollen further by springs, gathers into broader and yet broader rivers whereby the drainage of the land is carried out to sea. . . . . Here, then, is a vast system of circulation ceaselessly renewed. And in that system there is not a drop of water which is not busy with its allotted task of changing the face of the earth. . . . . It is evident that the general result of the fall of rain upon a land surface must be disintegration, and a consequent lowering of the surface. At first we may be inclined to imagine that this waste must be so slow and slight as to be hardly appreciable. But a little observation will suffice to furnish many proofs of its existence and comparative rapid progress in some places. . . . . The whole land surface over which rain falls is exposed to waste. As Hutton long ago insisted, "the superficial covering of decayed rock or soil is constantly, though slowly, traveling onward and downward to the sea."

Here, then, we find in water the only tireless agent that works in the modification of continents; and instead of being the great renovator of the land as it is popularly conceived, it is the great destroyer. The destruction of ancient Rome has been attributed to time. But it was due simply to the moisture of the atmosphere working through chemical agencies. It was water, invisible but penetrating even the very stones of the wonderful city, that caused her to crumble into ruins, and gave to modern Rome a grade greatly elevated above her ancient grade. But it works not alone in the cities and towns. There is not a hill on earth that has not been shorn of something of its altitude by this subtle force, and there is not a mountain on earth, if not fitfully renewed by volcanic action, that has not been compelled to lower its peak before this universal leveler of the exalted. It may be a dreadful thought, indeed, but we do not know absolutely that we are not dependent on the earthquake and the volcano for keeping our continental habitat above the level of the ocean; for water not only destroys, but it has the persistency and force to carry off to its burial

place in the sea all that it has caused to perish. It may take a long time at its task ; but working either in its gaseous, its liquid, or its solid form it seems to be the most persistent thing on earth, never perishing, and, however divided and invisible at times, always ready to unite its forces for a supreme effort at the degradation of a continent. Let us trace some of its operations and find our chief field for illustration along the Mississippi. Other and smaller rivers would serve, noticeably the Hudson and Delaware, streams that seem to have combined with the ocean for the purpose of forming all the low-lying lands of southern New Jersey, and the greater portion of Long Island. Other and smaller rivers, too, must contribute to the illustrations, in order that we may see that the Mississippi is no

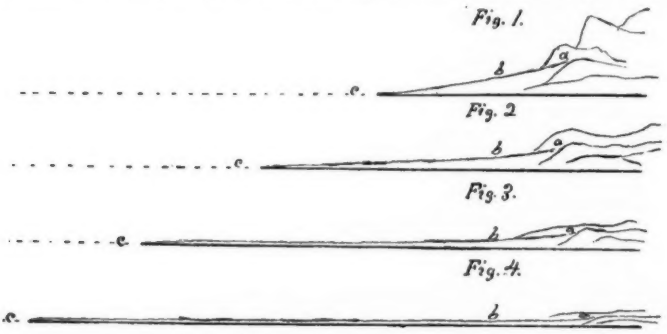


DIAGRAM REPRESENTING THE SLOPE OF THE MISSISSIPPI AT DIFFERENT GEOLOGICAL ERAS.

a a a a—source of river. b b b b—slope. c c c c—gulf or sea level. Fig. 1 represents the slope when the mouth was at the present location of Cairo.

lawless stream working without rule or precedent. But the Mississippi is our chief concern, and it can give us our most forcible lesson.

Let us first explain the diagram, presented herewith, intended to represent the slope of the Mississippi from its head-waters to its mouth. The Rocky Mountain and Alleghany Mountain tributaries of the river are not included in the sketch, because they are independent rivers and illustrate only a few of the laws that control the Mississippi. To many readers, therefore, the diagram may seem fanciful, because it depicts mountains at the source. But by the title it will be seen that the figures are intended to suggest the condition of the river at different and widely separated geological periods ; and it is entirely consistent with recognized geological phenomena to presume that the river once had its source among

mountains since disintegrated and moved downward to the lowlands and to the sea.

Figure 1 in the diagram represents the slope of the river as it might have appeared when its mouth was at the present site of Cairo. Like all rivers that take their rise among mountains or highlands, the slope is slightly concave, vertical waterfalls and sharply declining rapids forming frequent features of its mountainous section.

Figure 2 represents the slope of the river after its mouth had been pushed downward one-third the distance to its present mouth below New Orleans. But here it will be necessary to pause and explain how the bed of the river was raised at its original mouth, thereby seeming to illustrate rather the elevation than the degradation of continents.

Rapidly-flowing water, it is very well known, holds its sediment in suspension, and pushes along the bottom fine or coarse sand and gravel. But directly when the flow is seriously retarded it drops its sediment, and, of course, no longer has the power of moving substances having too much density to float. But the retardation of the current is what happens at the mouths of all streams. The current there not only is retarded, but it virtually ceases to flow; and then begins the familiar process of bar formation, a feature at the mouths of all rivers and creeks. First, a bar is formed, and, at the mouths of all great silt-bearing rivers, this bar soon rises to the surface of the water and assumes the outlines of an island. But the river still pushes out tongues of land to the right and left of this island, dropping its sediment wherever its flow is checked by contact with the open waters of the sea, and the island finally becomes only the contributing triangle of a delta. But the river is persistent, its work is never more than just begun, and it still pushes onward for a place of deposit in the more open sea. Finally it begins to close up the more torpid channels of its new delta, and to form first a new bar and then still another delta further on.

This is precisely what happened at the original mouth of the Mississippi, and it is precisely what has been happening, scores of times repeated, through all the unnumbered centuries that have since followed. But it does not explain the great elevation of the bed of the river at Cairo, it may be objected. No, but that is a phenomenon that will hardly need an explanation after the process already given in detail has been observed. Each year the river is flooded, and for weeks each year, for an indefinite number of cen-

turies, it has been pouring its sediment, vastly augmented by the floods and reinforced by floating vegetable and animal substances, not only out of its mouth but over its banks until the basin of the Mississippi has been lifted many feet above the level of the gulf. But the Mississippi has not wrought alone at this work. The Arkansas, the Red river, and many minor streams have contributed to the labor.

At the present time it is not probable that the bed of the river either at Cairo or for a considerable distance below Cairo is rising. A glance at Figures 3 and 4 in the diagram, after a look at Figure 2, will suggest as much; and though imperfections in the scale may make this testimony inconclusive, we know that the water is working with no purpose of leveling up the basin to a permanently higher grade. It has been making of the banks of the river only a scaffolding to receive temporarily the detritus passed down from above; but the full plan of the work will pull down the scaffolding in its turn, and deposit its contents far out into the Gulf of Mexico. It is probable that the work of demolition in the upper district is already under way. But further down the deposit of sediment in the bed and along the shore of the river is continued, and both the bed and the adjacent plains have still many feet to rise before they will be ready to join with the districts above subject only to the law of denudation.

Now, in the light of these facts, as well established as anything in the whole range of geological research, we must inquire if it is possible to build dikes along the shores of a great silt-bearing river without contributing to the elevation of the bed, while refusing to the adjacent basin the sedimentary deposits needed to keep it above the level of the stream. Good logic would be ready to declare even *à priori* that it would not be possible. The argument from natural phenomena will be so strong that the burden of proving dike-building harmless will seem to rest on their advocates. But after extended observation among the great silt-bearing rivers of the world we are not left to the necessity of reasoning *à priori*. We can establish ourselves on recognized facts.

As an object for illustration on this subject the river Po, in Italy, has been frequently mentioned. This is a great silt-bearing stream. During the eleventh and twelfth centuries it is said to have advanced its mouth into the Adriatic at the rate of about sixty feet annually. But it is very well known that not only this river but the Adige and Brenta as they flow across the plains of Lombardy

have raised their beds above the level of the adjacent country. True, geology does not claim that the beds were raised exclusively by the building of dikes. It sees no necessity for the coöperation of the civil engineer in the achievement of a work which nature herself is entirely competent to achieve. It is reasonably certain that the plains of Lombardy were created by those rivers, and in the beginning they were their own dike-builders, dropping their sediment to the right and left of their chief and most rapid line of flow. But it is so entirely consistent with the theories of geology to say that dike-building helps to raise the bed of a stream that Professor Geikie, when enumerating the performances of man in modifying the face of continents, and holding the Po within his field of observation, speaks as follows:

> By embanking rivers he (man) confines them to narrow channels, sometimes increasing their scour and enabling them to carry their sediment further seaward, sometimes causing them to deposit it over the plains and *raise their bed*.

This paragraph may be regarded as the expression of an authoritative geological opinion. But other scientific testimony is not lacking, and if it be not so direct as the testimony given above it is equally suggestive.

The peculiar formations known as terminal moraines left by the combined action of water and ice when the glacial period passed away has long been a subject for close study among geologists, and they have investigated along the borders of existing glaciers, and observed the streams and rivers issuing from beneath, to find the secret of those gravel ridges that everywhere mark the final halt of the northern ice-cap. The following passage is from an article by Professor Rollin D. Salisbury, geologist in charge of Pleistocene geology, on the staff of the geological board of the State of New Jersey:

> On passing from their subglacial to their open air courses existing streams carry much silt and sand and gravel. The same is probably true of them during their subglacial courses. If so, whenever their velocity is checked they are likely to deposit a portion of their load, and the portion deposited would be the coarser portion, since this is most difficult to carry. A subglacial stream might thus build up its channel, and if the subglacial course of the stream was closely confined by overarching ice the stream might not be able to abandon its bed even though this be higher than the land surface on either hand. Thus the subglacial stream might come to flow on a subglacial ridge accumulated in its channel, because the only course accessible to it was along this ridge.

Now, in the place of "overarching ice" in the above quotation

read "dike," and it will give us a very clear conception of the work in progress on the Mississippi.

It is idle to presume that a great silt-bearing river flowing sluggishly through a tortuous channel of its own making will ever be able to carry more than a very small moiety of its load to the sea in a single continuous portage. It will drop a portion on the bottom wherever its flow is retarded, and whenever it is flooded it must perforce carry another portion over its banks for deposit on the adjacent plains. If earth in sufficient quantities is carted to its shores to prevent its overflow, it will simply seize all that it can undermine and wash out of this earth on the occasion of its next flood and make it contribute to the elevation of its bed. This is the law established upon every observed principle of geological science, and we can no more prevent its enforcement than we can make the Mississippi flow up hill.

But what then? If the complete degradation of the continent is to be the final end, and if the land is to be eventually placed awash with the sea, will we not hasten the coming of the second deluge by shortening the channel of great silt-bearing rivers and facilitating their work? Possibly; but as Humboldt estimates the time required to prepare all the conditions for the catastrophe at four and a half million years even at the present ratio of waste, it becomes a question if the continents will not live as long as they are entitled to live in any case. Immortality enters into no theory of superficial terrestrial phenomena that has yet been advanced. And then, again, we should have some confidence in the wisdom of natural law. True, the theory that continents are to be preserved by seismic upheavals is not quite pleasant to contemplate, and it seems moreover to defeat itself by its own postulates. The day must come when there will be no more cooling at the interior of the earth to produce contractions of the crust, and then there can be no more upheavals. But the earthquake is not the only alternative. Nature must have contrived something better. Equilibrium and peace between the land and the sea must be finally established. When there are no more precipitous highlands, there will be no more torrents and floods, and all the rain that falls will sink quietly into the ground only to gush forth again in perfectly pellucid springs and to flow back to the ocean through the channels of equally pellucid rivers. It will carry no booty from the hill tops because there will be no hill tops to despoil. Man, too, may have his resources. In a good deal less than four and a half million years he

should learn to distill bricks from the elements, or, if necessary in order to keep his head above water, to build mountains of chemically produced granite. But, whatever the situation four and a half million years hence, it will not be worth while to make the Mississippi basin uninhabitable during the next few centuries for the mere purpose of promoting a wretchedly unscientific system of engineering.

There is but one treatment for the Mississippi which will be at once scientific and sensible, and this will be found in giving it a channel as nearly straight as possible from Cairo to the gulf. The river itself will do most of the work as soon as the needed cut-offs have been made; and once trained to follow a direct channel running with nearly twice its present velocity of current it will call for comparatively little subsequent expenditure. It is a wonder that the demands of navigation alone have not already compelled this kind of improvement.

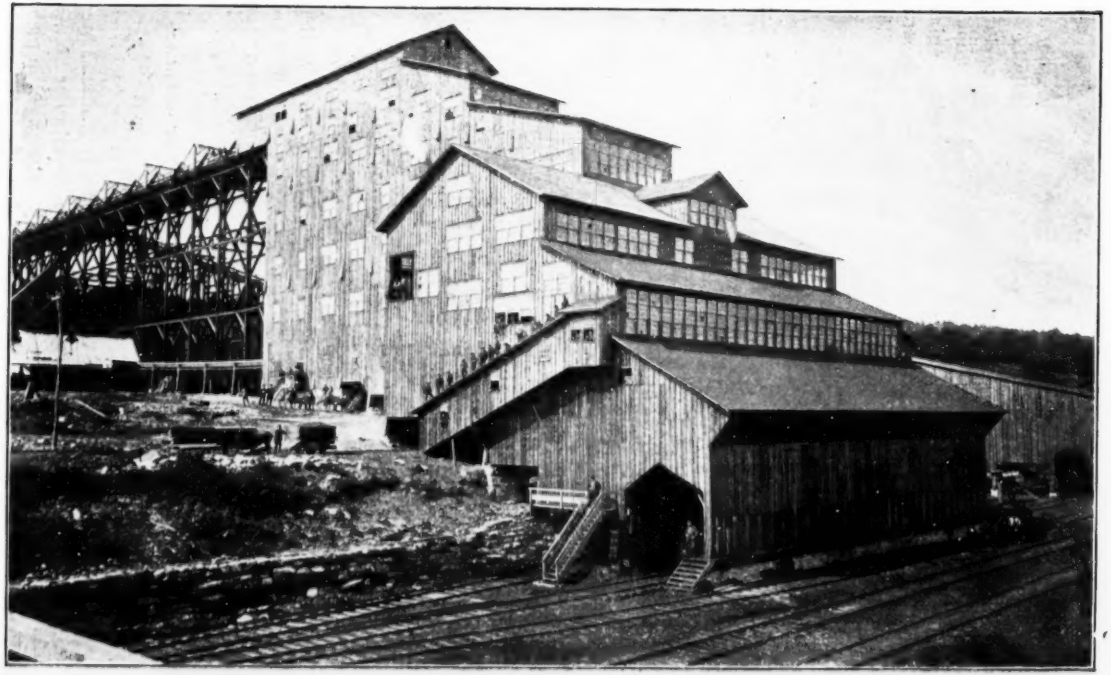
THE ANTHRACITE COAL INDUSTRY.

By H. M. Chance, E. M.

THE consumption of anthracite coal is rapidly increasing. It is estimated that the output of the anthracite coal basins of Pennsylvania up to the end of 1890 aggregated 700,000,000 tons, about three-sevenths of which had been mined in the last decade. The present rate of shipment from that section is about 40,000,000 tons per annum, which is the product of about three hundred collieries, giving employment to more than 100,000 men and boys. The total quantity of workable coal contained in the region has been computed at from 10,000,000,000 tons to twice that amount, but no really trustworthy data exist upon which to base an estimate. Probably the smaller figures are more nearly correct than the larger ones. With this quantity in reserve the present annual output could be maintained for two-and-a-half centuries, but under the present wasteful methods of mining and preparing the coal for market, even if there should be no increase in the annual consumption, the supply can hardly last more than a hundred years.

The anthracite-coal basins of Pennsylvania cover an area of about 475 square miles, in the northeastern part of the State, on the headwaters of the Schuylkill and Lehigh rivers and extending over to the waters of the north branch of the Susquehanna. In this territory are numerous canoe-shaped valleys bounded by mountainous rims of the great Carboniferous conglomerate. They are separated from the great bituminous-coal districts by a strip of country, barren of coal, from fifty to one hundred miles wide. No anthracite-coal beds are found in the bituminous districts, and no bituminous coal occurs in the anthracite region.

Whether these anthracite and bituminous coals owe their physical and chemical differences to varying metamorphosing conditions of heat or pressure or both, or whether these differences result from dissimilarity of the materials from which the coals were formed, is yet a subject of controversy. Those advocating the first theory appear to have the best of the argument. We know that heat or pressure or both may metamorphose a lignite into a bituminous coal or a bituminous coal or lignite into an anthracite coal, but we



AN ANTHRACITE COAL BREAKER.

do not know whether Pennsylvania anthracite is the product of similar metamorphism.

Dotting the surface of the valleys referred to are enormous piles of black mine refuse, near each of which can usually be seen a massive frame structure, blackened and begrimed with coal dust, and perhaps a large-head frame, with boiler- and engine houses, blacksmith shops, and other similar structures indicating at a glance the site of a great coal-mining industry. The large frame structures are known as "breakers," and may be likened to the mills of metalliferous mining districts, for in them the coal is broken, screened, washed, handpicked, and jigged to prepare it for market. A visitor to this section might do well first to go through one of these "breakers," and then, having observed the process of preparation, enter the underground workings and inspect the methods employed in mining the coal.

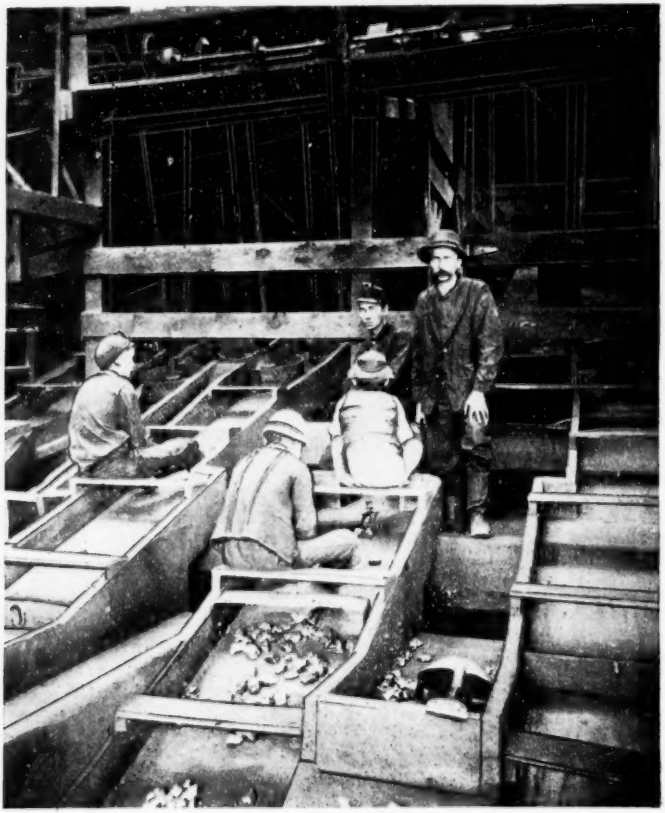
The building may be entered by means of an open stairway running up on the outside to the top, at a height of fifty to eighty feet from the ground. On entering through a door there may be dimly seen, through a cloud of coal-dust, a mine-car running in and landing upon a cradle dump. The car is ten feet long and holds nearly four tons of coal. As the coal is dumped it falls upon inclined screen-bars placed about four-and-a-half inches apart. The visitor may walk down a flight of steps, following the coal over the bars to a slightly-inclined iron "platform" where some men are examining the lumps that run down upon it. With a pick they separate any slate or bony coal adhering to the larger lumps and throw it into a slate or rock chute, where it can be seen sliding down into a car, to be run out and dumped upon the waste pile. The lumps of good coal are thrown into a hopper feeding a pair of rolls provided with steel teeth. The rolls are thirty inches in diameter by thirty-six inch face and may be set to break the coal into large or small sizes. The slaty coal is thrown into a hopper which feeds a second set of similar rolls.

Passing under the platform one sees coal, dirt, and slate pouring in great volume through the bars into a chute, and thence to a large revolving screen. Water is pouring down upon the screen, washing the coal, and carrying off the fine dirt, and the coal is coming through the meshes of the screen sized into four grades. Three of these grades are descending slightly-inclined chutes lined on each side by grimy boys and old men industriously engaged in picking out the slate and bony coal. The prepared coal passes them, slid-

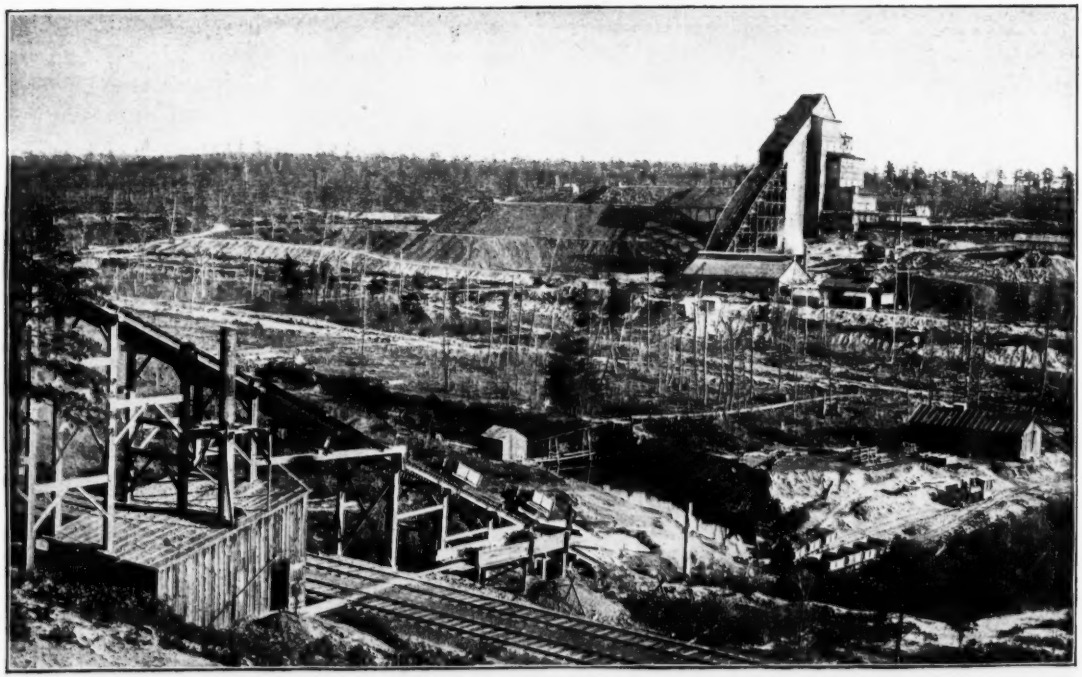
COAL-PICKERS AT WORK.

ing down and falling far below into great storage pockets. The fourth grade comprises all of the smaller sizes, from a quarter of an inch up to 1½ inches, and this we follow through a chute into a revolving screen with finer meshes, which separate it into several small sizes, each of which passes through a chute to a jig, where the slate is removed, and finally to its proper pocket.

Ascending again to the rolls, we follow the crushed coal down through a process similar to that already seen, except that the coal is screened and picked dry, the smaller sizes only being washed and jigged. Near the bottom of the breaker is a small pair of rolls at



SLATE-PICKERS AT WORK.



A COLLIERY AT MOREA, PENNSYLVANIA.

work rebreaking pieces of slate and bony coal interleaved with good coal, which have been separated from the larger sizes of coal by the slate-pickers. This material when crushed is raised by a bucket elevator to a screen and after sizing is fed into the jigs to be separated. At many breakers the system of preparation is more complicated, the coal being broken and rebroken, screened and re-screened, the bony coal picked out and rebroken to smaller sizes, the smaller sizes jigged, and the larger sizes jigged and repicked.

If the slate mixed with the coal is in thin flat pieces, it is removed by mechanical "slate-pickers." These are segments of cylindrical screens made of narrow slits (instead of square meshes),

OPEN-CUT WORKING ON MAMMOTH BED NEAR SHENANDOAH, PA.

which allow the slate to pass, but retain the coal. Other mechanical slate-pickers are based upon the fact that in sliding down a sheet-iron chute coal acquires greater velocity than slate.

From the breaker we pass to the engine-house, where a double conical hoisting drum is seen, driven direct by a pair of twenty-four-inch engines with five-foot stroke. The head-frame is an open iron or steel structure, erected over one-half of the mine-shaft. At one side of the shaft stands a fan, thirty-five feet in diameter, driven by a separate engine, exhausting 200,000 cubic feet of air from the mine every minute. The shaft contains four compartments, of

which two are used for hoisting coal, a third for the pumps, and a fourth to furnish area for the passage of the outflowing air-current.

Descent into the mine is by means of cages ten feet long and six feet wide. We step upon one of them and in thirty seconds are a thousand feet below the surface. The two cages, one in each shaft, easily handle a thousand tons of coal in ten hours. From the cage we walk along the gangway, which is twelve feet wide and seven feet high inside the timbers. A strong current of air is flowing past, moving faster than we walk. Opening a door, we pass through a cross cut into the airway, where the ventilating current is moving even more rapidly, but in an opposite direction. Passing

A GANGWAY IN THE MAMMOTH BED.

through a door into a room, we are soon at the "working-face," where a shot has just been fired and the miners are engaged in loading the coal. Here the full size of the seam is visible. It is fourteen to sixteen feet thick, and, being inclined only about ten degrees,—by running the rooms at an angle to the pitch of the bed —the miner is enabled to bring the mine-cars directly up to the working face. The coal is broken from the solid by holes drilled in the face. There is no undercutting, no pick work, no machine-cutters; in the eyes of a soft-coal miner, it is not mining, it is more like quarrying, or tunneling, or stoping.

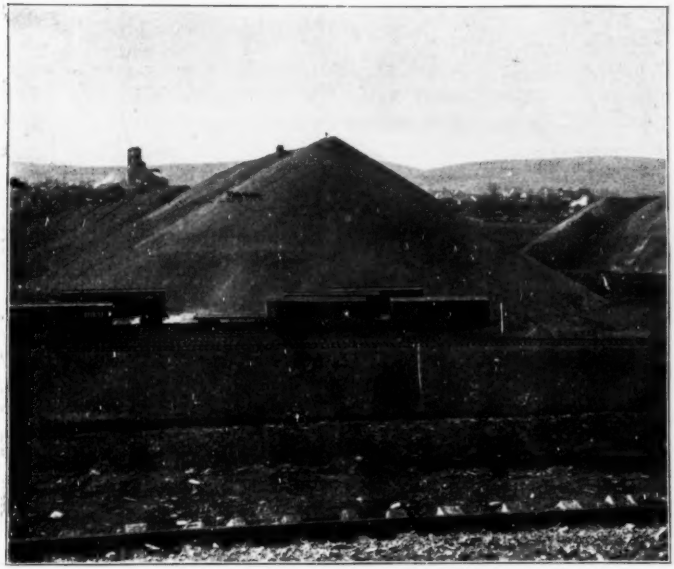
In the middle coalfield the Mammoth bed attains its greatest development, maintaining over many square miles a thickness of from thirty to fifty feet. Here sharp dips prevail, and the coal is usually developed and hoisted through slopes sunk upon the outcrop of the bed. We may visit the underground workings of one of these mines either by riding down the slope on an empty car, or by walking down the slope or airway. As we descend we pass gangways at nearly regular intervals of about one hundred yards, until the bottom is reached, at perhaps the sixth or seventh "lift," which is the term by which each level is known. Walking along the gangway, we enter a "breast" after a tedious and difficult climb

GANGWAY AND ROOMS IN THE MAMMOTH BED.

up a narrow chute. We are here standing upon mined coal; the solid coal forms the roof above, but in many places is out of sight. We are conscious of the same feeling that one experiences upon entering a great natural cavern. Should we enter a breast where the pitch is not so steep, or one from which the coal has been completely drawn, we would realize even more fully the gigantic scale upon which nature has here provided for the needs of man. Imagine a chamber fifty feet high, thirty-five feet wide, two hundred and fifty feet long, steeply inclined, with black walls that reflect no light, and in which the feeble light of our lamps serves

only to illuminate the darkness until an almost visible blackness surrounds us,—such is a worked-out breast on the Mammoth bed.

The photographic illustrations of gangways on the Mammoth bed and of open-cut mining near Shenandoah were made from flash-light negatives kindly loaned the author by Mr. E. B. Harden, M. E., by whom they were taken. These are among the best underground photographs yet secured. The principal trouble with underground photographs is that they fail to convey a correct impression of the real appearance of the interior. In a mine every-



WASTE DUMP NEAR SCRANTON, PENNSYLVANIA.

thing is black ; the walls are black, the floor and roof are black, but all over the surface of walls and roof and floor are small sparkling jet black faces of freshly fractured coal. To the eye it is all black, but the camera reproduces each glistening black spot as a white one.

There are about thirty well-defined anthracite-coal beds, scattered through about 3000 feet of sandstones, slates, and shales. In no part of the region are all these beds of workable thickness, and it is unusual to find more than eight or ten thick enough for profitable mining at any one place. Each seam thickens and thins inde-

pendently of those above or below it. The beds now being worked are from three to sixty feet thick. The region is divided into three main basins and a number of smaller ones, by a series of more or less sharp anticlinal and synclinal rolls. While the beds are thus uptilted at all angles from vertical to horizontal, steep dips prevail over most of the region, comparatively little coal being mined on dips of less than twenty degrees, except in the Wyoming basin where flat-dipping coal extends over a considerable area.

Large quantities of marsh gas or "fire-damp" occur in all of the deeper workings, necessitating large gangways and airways for its efficient dilution and rapid removal. As these would be inefficient without correspondingly large shafts and slopes, the hoistways are of extraordinary size. Shafts sunk to develop the deeper portions of the basins often measure in the clear—inside the timbers—from ten to twelve feet wide and from thirty-five to fifty feet long. These large shafts are divided into several compartments, and two cages are commonly used for hoisting coal and one or two for raising and lowering men, mules, tools, and supplies. A second opening is required by law at all collieries. It is utilized as an airway, for lowering men and supplies, or as a pump-way.

Levels known as "gangways" are driven from the bottom of the shaft, or at intervals of about three hundred feet from the slopes, in both directions, and from them the rooms or breasts are opened. Parallel with each gangway and distant from it thirty to sixty feet, an airway is driven. At intervals of fifty to one hundred feet "cross-cuts" are driven connecting the airway and the gangway, by which ventilation is maintained during the driving of the gangway and the airway. The cross-cuts are made as small as possible and afterwards closed by plank or masonry "stoppings."

The breasts or rooms are the working places where the coal is mined. They are opened by a chute six to ten feet wide, driven up through the coal a distance of thirty feet or more, before the breast is open to its full width, which, depending upon the nature of the roof, may vary from twenty-one to thirty-six feet. The breasts are opened at such intervals as to leave a pillar of coal separating them from eighteen to thirty feet thick. Cross-cuts are driven through the pillars to allow the ventilating current to pass from breast to breast. In many cases the breasts are opened by two chutes, one on each side, separated by a pillar of coal called a "stump" about eighteen feet wide.

The illustrations showing the methods of working breasts were

MINE NEAR SCRANTON, PA., OPENED BY DRIFTS ON FLAT DIPPING BED OF COAL.

MINERS AT WORK, PHOTOGRAPHED BY ELECTRIC LIGHT.

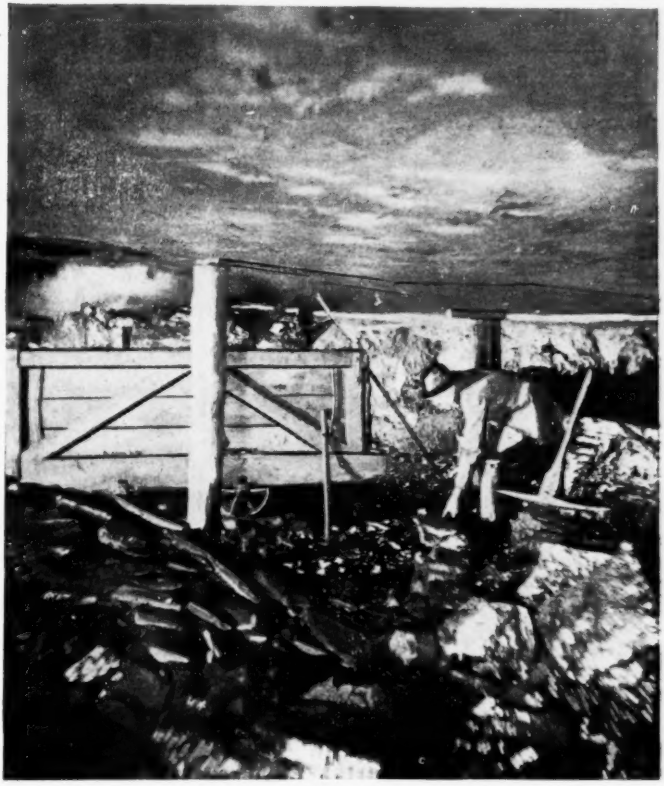
originally designed under the direction of Mr. J. Price Wetherill and were used in the reports of the Pennsylvania State Geological Survey, from which they are here reproduced by permission.

When the bed exceeds ten feet in thickness and is inclined more than thirty-five degrees, the breast must be kept full of mined coal to give the miner something to stand upon to reach the coal above him. In such cases the chutes by which the breast is opened are extended up through the loose coal by manways built of timber in one corner of the breast. When the coal-bed contains bands of slate, aggregating about one-half the full thickness of the seam, the breast may be filled with this waste instead of coal, the good coal being sent down the chute as fast as it is mined.

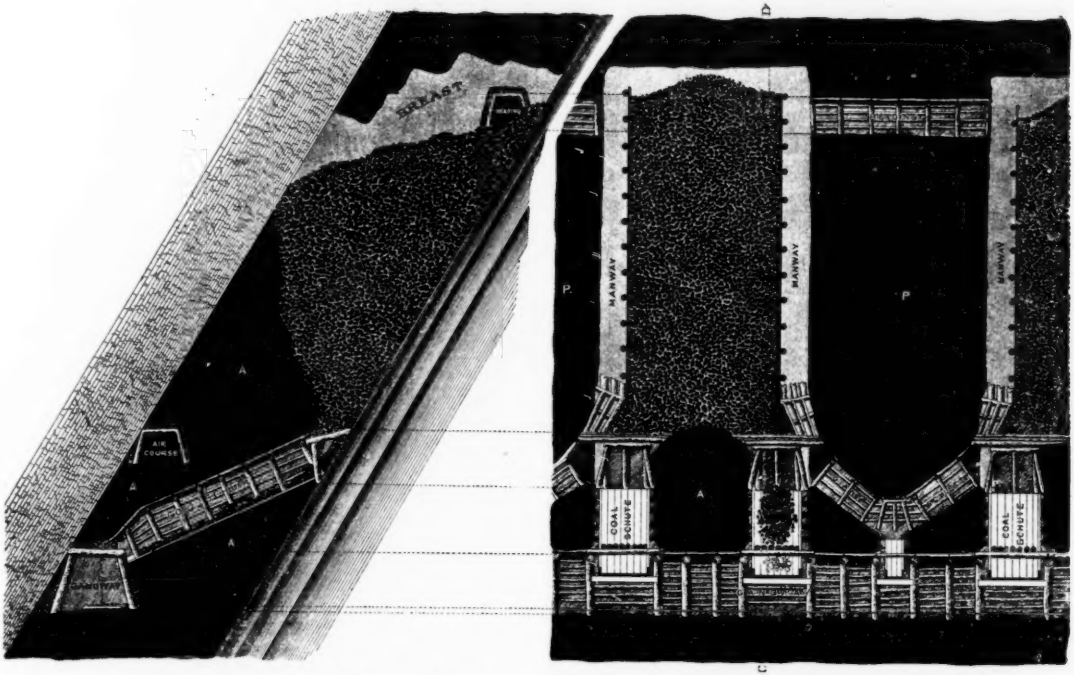
The manways give the miner two ways of going from the

gangway through the loose coal or slate to the top of the breast. One or both of these manways is used as a chute for sending down the surplus coal mined each day in driving the breast, and also as a traveling-way, and both or either may be used as airways. The coal is loaded by gravity from the chute into cars standing in the gangway below. When the breast is worked up nearly to the level of the gangway above, it is abandoned, and the loose coal it contains is drawn through the chute and sent out of the mine.

When the bed is less than ten feet thick, the miners may work on platforms built on timbers wedged between the roof and floor, and when the pitch of the bed is less than thirty-five degrees no



MINER AT WORK IN A ROOM LOADING COAL. BED ABOUT SIX FEET THICK AND NEARLY FLAT.



METHOD OF WORKING A THICK BED STEEPLY INCLINED BY DOUBLE CHUTES.

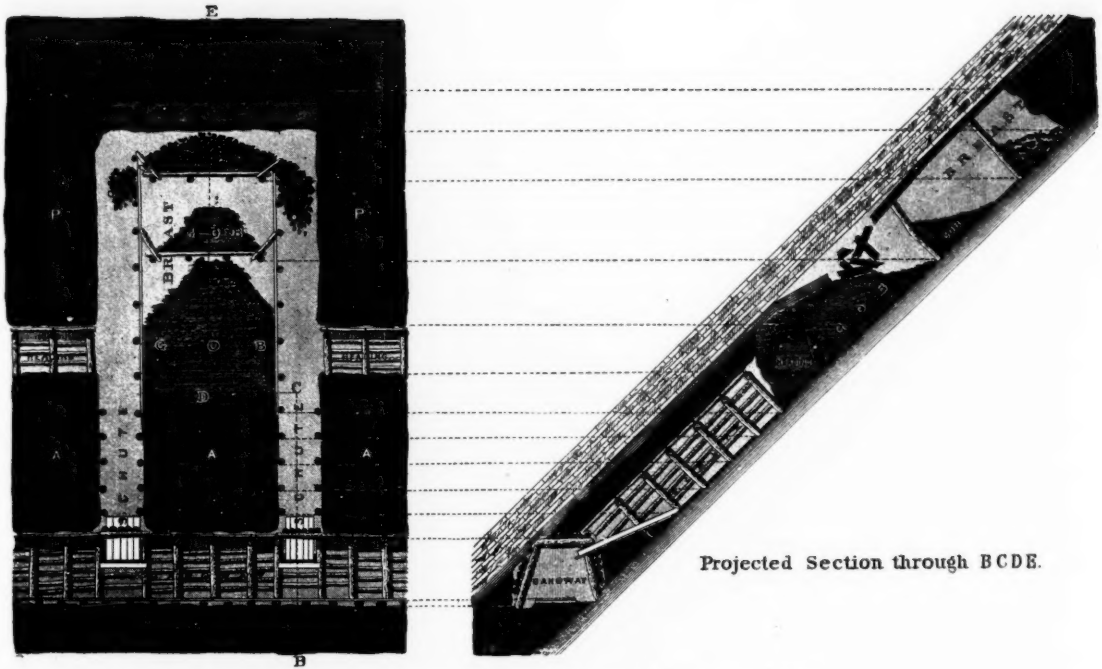
[Scale about 25 feet to the inch.

artificial support is needed, and in either case the coal is allowed to slide down the floor into the chute and is loaded into mine-cars as fast as it is mined. When the pitch of the beds is less than twenty degrees, the coal will not slide down to the gangway, even on sheet iron, and must be transported in a small car called a "buggy" from the face of the breast to the gangway, where it is dumped into a chute or loaded direct into the mine-cars. When the pitch is less than six or seven degrees, the mine-cars are taken into the breast,—then generally called a "room,"—and the coal loaded direct from the working-face into the car.

While other plans have been proposed, the old method of working by parallel breasts separated by regular pillars of coal is still almost universally used. That great waste results from this method is admitted by all. In working thin beds the pillars can be removed, or at least a large portion of the coal they contain can be taken out, after the rooms are worked to the limit, but this can be done to very limited extent in thick seams. By adopting modifications of the long-wall system, or combined long-wall and refilling systems, a much larger percentage of coal in the thicker seams could be recovered, but such systems would perhaps increase the cost per ton, and they require a large preliminary outlay in deadwork before mining on a large scale can be commenced. Conservative estimates place the quantity of coal lost by being left in the ground as pillars at 40 per cent. of the quantity originally present.

The cost of mining and preparing coal for market varies widely between different collieries. When the coal is wet, and contains much bony coal or slate, the cost of preparation is largely increased. Perhaps $1.40 to $1.90 per ton may fairly be taken as the average range in cost of production and preparation. This is exclusive of royalty, which averages from thirty to forty cents per ton. Enormous quantities of water are pumped from some of the mines, several raising between 1,000,000 and 2,000,000 gallons daily.

In addition to the coal lost in pillars left to support the roof, a considerable portion is lost by becoming mixed with the "gob" or refuse left in the mine; some is reduced to dust by blasting and handling, still more waste is made by crushing, screening, and handling in the breaker, and the rejected slate always has more or less coal adhering to it which is lost in the waste dump. Less than 45 per cent. of the coal contained in the thicker beds is sent to market, the balance being wasted.



METHOD OF WORKING THIN BED STEEPLY INCLINED BY DOUBLE-CHUTE BREASTS.

[Scale about 20 feet to the inch.]

FIRE LOSSES AND THE AGE OF CLAY.

By Harvey B. Chess.

LAST year the United States converted into ashes and smoke property for which the insurance interest, as its share of the much larger total loss sustained, paid $142,000,000. We may appreciate what this draft on our national resources means by reflecting that the full value of the pig iron production for the same period was less than the sum named by $20,000,000. Treasure equal to one-and-one-half times the wealth gained by energy and toil in the great industry of iron production was completely obliterated. If it be true, as asserted by a prominent underwriter, that in the recorded history of his company 40 per cent. of all fires appear attributable to easily preventable causes, then neither from an economic nor from a practical point of view is the general fact stated creditable to our national intelligence.

How shall we build safer, and come within the unavoidable commercial limitations imposed? The writer begs to present an answer the pith of which is a reformation in the usual method of treating an element used in nearly all building construction,—namely, the plaster. Homely things are often of prime importance.

The May number of this Magazine contained an able, but rather pessimistic review of the fire-resisting shortcomings of granite and other stone, as also of iron and steel, written by Mr. Edward Atkinson. This gentleman inquires whether "we may not now be about to enter upon the *Age of Clay*, having passed through the several phases of timber, light-wood, iron, granite, and steel." By implication, I think Mr. Atkinson uses the word "clay" as the type of plastic earthy materials in general, of which clay is certainly the most notable in its applications to building purposes, as well as in the manufacture of domestic utensils, having been thus used from remote antiquity. But when the author of this interesting paper ventures to assert "that we have as yet no science applied to bricks; no science applied to mortar or cement; no true art of construction in brick, fire-clay, and tile,"—I cannot accept the statement unchallenged.

I am willing to admit that there is yet much to learn. Chemistry has been an acknowledged science many years, but it has

placed to flash fire along to studding, joists, and roof-timbers. It readily supplies the 600° heat needed for the ignition of larger sections of the framing. At just the proper period it treacherously drops its armor, lending itself with fatal facility to the enemy.

Eliminating a large share of these adverse conditions, incombustible metal foundations for plaster have been introduced. They have been sufficiently used and tested under trying conditions to have their great merit universally recognized. A list of important buildings of New York city alone in which such foundations for plaster have been employed would surprise the public by its extent.

To show what are the capabilities of these foundations an experiment must be cited, premising that the result, as stated, is in no way remarkable to the initiated. A structure eight feet square, built of fire-brick, was roofed with common 2″ x 12″ hemlock joists at ordinary spacing, and with a clear space of five feet from the ground. The ceiling was common plaster, applied to a metallic lathing, and at each side, just beneath this, were small openings to permit egress of smoke and flame, as windows do in a burning building. Two larger arched openings at the ends and at the bottom permitted stoking and full air-draught. The joists were covered loosely with sheet iron laid upon them. A fire was started in this structure with fuel entirely composed of old saturated oil and resin barrels and vigorously maintained for one and one-quarter hours, and until an insurance expert, who was present, expressed himself thoroughly satisfied with the test.

Here was a sheet of only common mortar interposed between heat energy in volume and kind rivalling that of a foundry cupola,—some 3000° to 3500°,—and yet the highly combustible joists immediately above it did not ignite, though subjected to the test for seventy-five minutes. Would not any of the materials above enumerated and hitherto so much trusted as fire-proof have failed to endure such a test? If it be answered that this statement is *ex parte*, I will cite one against which no such claim can be urged, a test "undesired, unexpected, and severe," to quote the language of a well-known firm of New York architects who planned the structure:

The six-storied building—Nos. 115–119 Prince street, New York;—walls of brick and floors of wood joists laid with yellow pine flooring;—ceiled with metal lath coated with common lime mortar. Plastering was finished throughout, and the plumbers and fitters, having improvised a shop in a second-story room, had gathered there their material: coils of pipe, jute, hemp, resin, etc.; when, on the night of Nov. 21, 1890, a fire broke out in this room and consumed the entire contents, including lumber and rolls of lead pipe, the latter being reduced to a

liquid which spread over the floor. The point of this is, the fire was confined to the room in which it originated, and the plaster was unaffected and none caused to crack or fall. We have no hesitation in saying the lathing was the means of preserving our building and preventing the fire from passing from one floor to another and thus destroying it.

The owner, a shrewd man of affairs, not only verified this statement, but used the incident to such advantage in negotiations with his insurance companies that he now asserts "it pays to use fire-proof lathing" from the actual reduction of rates.

The following is from an English source, but it refers to metal lathing of American origin. Messrs. Mappin Bros., No. 66 Cheapside, London, E. C., under date of December 28, 1891, write: "It is with much pleasure we are able to inform you that during the fire which occurred here in the basement of our premises on the 18th inst. the fire-proof lathing in the ceiling proved the means of saving the entire building. The fire occurred in the basement, which is used as a storage and packing room, the ceiling of which is only eight feet high, and notwithstanding the fire raged with great severity, deeply charring all exposed woodwork, the ceiling otherwise remained intact and uninjured, thus confining the fire, which otherwise must have spread throughout the building."

Messrs. Holliday and Greenwood, eminent builders in London, give their experience under date of June 24, 1892: "We have used considerable metal lathing in public buildings in London; but hitherto none of these have been attacked by fire. Being desirous however to confirm our opinion as to the fire-resisting properties of this material, we constructed on our premises a section of an iron and concrete floor some four feet from the ground, and loaded it to about 200 pounds to the square foot. The ceiling was, in this instance, formed of the metal lath which was suspended below the surface of the concrete (so that the concrete itself might be protected from excessive heat by means of this air space) and then plastered in the ordinary way." The sides were closed in, a door space left, and an iron flue connected with the inclosed space to afford ample draught. This furnace, for such it was, "was then filled with pitch-pine logs, tar, and other inflammable material, and ignited. It burnt fiercely for some time. We then subjected the ceiling to a further test of throwing cold water over it, and thus suddenly reduced the temperature. When the ceiling was examined, we found that, although it was, of course, blackened and discolored by the flame, both it and the concrete above it were perfectly sound."

Coming back to our own country, within a few months "undesired tests" have been made in two cases. In an important hotel in Chicago a fire occurred near the elevator shaft and, running up through it, burned back some little distance on several of the floors; but, as the ceilings were of plaster on metal lathing, the fire was easily controlled, causing only small damage and merely a nominal loss to the insurance companies. Recently, the large Athenæum building in the same city, eight stories high, devoted to educational purposes, and containing painters' studios, rooms for physical culture, the study of music, etc., had a fire in its upper part. The seven lower stories were in wood joist and studding covered with metallic lathing throughout, while the upper one was done in wood lath on the same wood construction. This whole upper story was consumed by the fire. The floor and some of the partitions of the next story below were burned out; but the lathing held the plaster on the ceiling so that the progress of the conflagration was slow, and so that, when the building was flooded with water, the latter was retained. Thus the fire was drowned out with no damage to lower parts of the building, and only the two upper stories were destroyed.

Lately there was a fire in the basement of a building in New York city, owned by Mr. Orlando B. Potter, where the tenant had allowed a large heap of wool-cloth clippings to accumulate. The ceiling overhead, being plastered on metallic lathing carried on wood joists in combination with a layer of deadening mortar and common flooring, successfully withstood the attack of a raging, seething fire nearly the whole of one night. While it is true that the deadening combination above was valuable, the main fire resistance came from the plaster protection of the supporting joists. Some slight change in method of attachment of the lathing was the only improvement suggested to the owner by this unlooked-for demonstration. Indicative of the intense heat of this fire is the fact that certain heavy brick pillars surrounded by the burning mass were shattered to a depth of from sixteen to eighteen inches from the surface.

Very recently Mr. Potter, whose advocacy and example of good building has a national reputation, has said that "especially in those buildings that are desired to be to a high degree fire-resisting" metallic lathing "approaches in its permanency and security, as a fire-resisting ceiling, to that obtained by solid metal or masonry," and added that "this saving construction ought to be, and,

as soon as understood, *will be*, extensively and progressively used throughout the country." This testimony is not *ex parte*.

Permanent reforms come slowly. Time must be had for testing all innovations before their general approval and adoption. Five years' experience has shown the utility of metal lath and mortar as a barrier to the progress of fire, and millions of dollars in buildings so treated have been shielded from destructive conflagration. While owners of such buildings, thus far, have not had the advantage of lower rates that should have been accorded, except in a few instances, there are now strong indications that the sagacity of the managers of insurance companies is pointing their attention to the wisdom of a just discrimination in their favor, and that a new order of things in the business of underwriting is at hand. Readers who contemplate building may question the cost as compared with the older system. The additional outlay in erecting a six-story store-building 20′ x 120′, with wood joists, would be about $400. The interest, at 6 per cent., on this investment,—$24 per annum,—would be more than reimbursed by decrease of premium on the building and its contents allowed by intelligent underwriters.

A frame dwelling of ten or twelve rooms will ordinarily contain one thousand square yards of plastering. When metal lathing is used, the cost will be from twenty-two to twenty-five cents per square yard more than when ordinary wood lathing is employed; making an additional outlay of $250 on a $5000 house.

The interest on the increase of outlay would be $15 per year. This is a practical kind of self-insurance that, sooner or later, must be recognized by insurance companies. The application of the system to a brick building of similar dimensions would cost a little more than half the above named increase—say three per cent. of the entire cost. In a brick house of the same size costing $20,000 an investment equal to three-fourths of one per cent. could easily be balanced by a slight chastening down of a too often meretricious style of trimming.

It may not be amiss to describe here a unique partition which has attained quite a popularity in the Northwest as being more economical and structurally better than the tilings heretofore used.

Metallic lathing is wired to light iron channels, spaced as studdings on this diaphragm core; by applications of mortar to each side, the adequate thickness (usually 1½″, in all) is attained. The structural merit of this new kind of partition is indicated by its adoption in edifices such as the Armor School and the Dexter

Building in Chicago. This construction is here named as typical and as being an American adaptation of the well-known Monier system of arch-building. It suggests a probable wholly incombustible construction of moderate cost in the near future, wherein both studding and joists shall be of steel in some lighter and cheaper form than the usual rolled section.

Analogously, by a small outlay, iron or wood girders with their supporting columns of iron are prevented from treacherously failing at the critical time.

The heat developed in the burning of floor constructions alone in an ordinary four-story building, 40′ x 100′, is sufficient to easily melt 40,000 pounds of metal in a cupola; or to use another illustration, if it were applied through two hours in a common mill furnace it would maintain the 3200° temperature needed to bring 7000 pounds of iron to a welding, dripping heat.

To slow down, baffle, or completely resist such a destructive force has been the difficult constructive problem solved by the system herein described. It is small wonder that our efficient fire departments are considered as doing well if they limit a fire to the structure attacked, and protect its neighborhood from disaster.

Metallic lathing on light iron false framing is invariably used in the highest grade of fire-proof construction in cutting off roof spaces, and in other multifarious situations where a foundation of masonry is out of the question. Disregard of such smaller precautions precipitated the Western Union Building disaster.

Another argument in favor of this superior foundation for plastic work is that in these days of beautifully modeled interiors the shaping up, the color, and applied decorative treatment are too costly to risk on anything else. The new Madison Square Theater, the Greenwich Savings Bank, and Temple Bethel, New York, and the new German Theater of Chicago, are superb examples of interiors, "as good as they look" in point of safety and fire-resisting quality. While this paper was in preparation, the burning out of the Metropolitan Opera-House took place. Its undeniably good construction did not save it; but, permitting most efficient work by the firemen, it largely mitigated the loss.

The great fires of Chicago, Boston, and St. Johns were, in the main, the aggregate of many units of fatally "quick-combustion." If, by use of the constructive feature I have described, each unit had been rendered much more resistant, it is not too much to say that the separate results of these fires would have been far different.

THE TRUE CAUSE OF LABOR TROUBLES.

A REPLY TO MR. HARRAH ON "LABOR TROUBLES AND THE TARIFF."

By Jno. Gordon Gray.

IT is an encouraging evidence of the widespread interest in labor problems, and the desire to reach fair-minded and impartial conclusions on the part of a class against which there has been but too often exhibited a disposition to see in it nothing fair, generous, or even honest, when one of that class, himself a capitalist and large employer of labor, is found so plainly anxious to "hold the balance level" as is Mr. Harrah, in writing of "Labor Troubles and the Tariff," in the last number of this Magazine. Mr. Harrah, indeed, stands so erect that there is even a suspicion that he leans backward, and so evidently has he imbued himself with the spirit of modern demagogic agitation that he quite unconsciously uses the cant phraseology of that cult without appearing to see whither it must lead him.

"The employer," says Mr. Harrah, "is in continual dread of the demands which he feels his hands are about to make on him for an increase in remuneration, and the workingman knows that his employer is thinking of how he can extort more products from him and at the same time pay him less money for what he actually does produce." Extortion is an ugly word. What evidence exists to justify it? That is not Mr. Harrah's attitude towards his workmen; are other employers less just or less wise? Every employer indeed must constantly study how he shall meet the competition which ever threatens to overwhelm him, and seek with never-ceasing labor and anxiety new methods of increasing production, that neither he nor his workmen may be left behind. These ends are not to be attained, however, by extortion practised upon his employés, but by better system, by improved machinery and processes, by the application of sound economic laws. What really is the principle underlying the relation of employer and employed, whether or not the employed know it, or the employer means it? Is it not that the private in the industrial battle counts for more as a unit in an army than he possibly could as a unit fighting for himself? The system, the exacting rules, the pressure to bring out the working

power of the man,—are not these the application of inexorable industrial laws, without which nothing would be accomplished either for the workman himself or for the capital which gives the workman's powers an opportunity for development? Not the least thing which the workman owes to the employer is the moral reënforcement which often supplies the lack of energy and will on the part of the employed, and which enables many a workman to do infinitely more for himself in the struggle of life than he could ever accomplish alone. This may be work extorted, but not in the sense in which the word is used in the cant of labor demagogues.

"During the past twelve months," says Mr. Harrah, "we have seen civil war . . . troops have been called out, martial law proclaimed, and indictments for treason, murder, and conspiracy found by grand juries. . . . Surely there must be some cause for these tragedies and some remedy. The cause is easily found. Dissatisfaction at the wages offered by the employers and the folly of a handful of ignorant demagogues on the one hand, and, on the other, tyrannical assumption of power on the part of subordinates. . . . That the remedy for this state of affairs should be martial law and criminal indictments no thinking man will ever admit." Accepting Mr. Harrah's explanation of the cause as sufficient, for the present, I will merely remark that we have here an example of that impartiality which is often most exasperatingly partial and unfair,—an equal weight of censure laid on both parties to a quarrel, without investigation to determine whether one may not be guilty and the other innocent.

But the grand juries determined that murder had been done and that conspiracy existed. If criminal indictments be not a remedy, they at least are legal steps in the direction of punishment, and if we should discard socialistic formulas and apply the old-fashioned terms to criminal acts, exemplary punishment would be a satisfactory sequel to the commission of wickedness and folly. That criminals may go unwhipped of justice through the difficulty of securing juries and a false state of public sentiment is the disheartening side of the matter.

Proceeding, Mr. Harrah finds three measures on the part of the men, and three on the part of the employers, the enforcement of which by acts of Congress would, in his opinion, be beneficial. First of those relating to employers is the total removal or the reduction in part of "prohibitive duties." The paragraph in which Mr. Harrah justifies this remedy is so extraordinary in its contradic-

tions that it gives the reader the sense of mental strabismus. His proposition is to remove the duties on the articles made here in order that workmen who have been dissatisfied with their wages may be made contented and happy. No part of the discontent existing at Homestead has been alleged to be due to the coming here of English mechanics to compete with Americans. But by some process of reasoning Mr. Harrah reaches the conclusion that the incoming English workmen are a factor in the situation for which a remedy must be found. This, however, is easy for Mr. Harrah, who proposes to let them stay at home. "And this can be easily accomplished by the removal of such parts of the custom duties as are now depriving them of their means of livelihood by shutting down their mills. Restore to them the markets they have lost, and they will certainly be content to stay at home, rather than to come here to compete with our workmen for the amount of work offering, which is already too little for the claims of the latter."

Surely this is an extraordinary proposition. We have too little work here for our own people, and therefore we should restore to the English the markets they have lost,—that is, our market which is already too small for our own people,—in order that they may start up their mills and send us goods again. Otherwise we shall have the English over here. But Mr. Harrah has already said that these are very desirable people, and if it is a question between the goods and the men (who will bring their wives and children), surely the men are better. They would not only produce the goods here, but they would live in houses built by American mechanics, which cannot be imported, and live largely on perishable products of the farm, which cannot be exported. The removal of the duties, Mr. Harrah tells us, "would have a result far beyond the effacement of the danger of an invasion of foreign skilled cheap labor. It would open to us the markets which we have closed against ourselves." What markets? We have just seen that English mills are shut down because our market was closed to them. We are to open our market to the English in order that their mills may start up and supply us with goods, while we are to go out in search of the shadowy, mythical "markets of the world." If these markets are to be opened to us, why did the English shut down their mills instead of keeping merrily at work and occupying these markets themselves?

Mr. Harrah's plan, to quote him further, "would enable us to increase the number of the employed by this extension of production . . . and the steadiness of the employment would more than

compensate for any slight diminution in the wages which might have to be made in order to meet foreign competition." Thus, the English mills are idle, being shut out of our market. We are to open our market to them, setting their people to work, and by so doing are to increase our own production and keep our men more steadily employed, contenting them with lower wages, when formerly they were fully employed at higher wages.

Mr. Harrah's second remedy is an honest currency. Every thinking man, to use Mr. Harrah's phrase, will agree with him that an honest currency is not only desirable, but ultimately imperatively necessary. But not every thinking man will see, either in the past year or at the present time, any necessary connection between the currency and the labor troubles. Mr. Harrah is here betrayed again into the loose use of objectionable phrases, when he speaks of the employer's rascality in paying his workmen in debased money, although it is true that he places the responsibility on the Government. But why "rascality"? That sounds too much like the labor demagogue. If it be rascality in the employer, it is rascality in the workman who passes this same dollar over to his grocer, and in the grocer who pays it to the wholesale merchant, who in turn plays the rascal when he pays it to Mr. Harrah for the girders for his new building. Thus we are all rascals together. As a matter of fact, wherein has the workman suffered yet from the currency? If he does not like the silver dollar, he can easily get a gold dollar for it, and with either the gold dollar or the silver dollar he can buy more of the necessities or the luxuries of life than at any time for twenty years past. And for his labor he can get more of these same gold and silver dollars than ever workmen got before.

Mr. Harrah's third remedy, which he terms the most important, is the prevention of adulteration. Honesty is much to be desired, and the lack of it is the cause of much loss, trouble, and vexation, —of wasted lives, injured bodies, and untold expense. But what necessary connection has adulteration with the tariff? Has free-trade England no adulteration? On the contrary those who are informed upon the subject know that nowhere else has adulteration penetrated more deeply into manufactures or been reduced more completely to a science. Ever since the publication in the *Cornhill Magazine*, thirty years ago, of a series of articles upon the evil of adulteration in England, there have been parliamentary commissions, newspaper campaigns, and occasional popular assaults upon it, but all without avail.

On behalf of the workmen the three features proposed are piece-work, the eight hour law, and arbitration. Piece-work is right in principle and has been steadily gaining ground in practice. There are now few large manufacturing establishments where it has not been adopted in whole or in part. But as a panacea for labor troubles? It was the high-priced piece-workers who caused all the trouble at Homestead. The workers by the day were not heard in the dispute; they only suffered from the action of their co-workers.

As for the eight-hour law, undoubtedly the trend of thought and practice is in the direction of shorter working days, and it requires no very long memory or extended experience to enable one to note great changes in this regard. There can be no doubt that with improved machinery, and more complete control over the forces of nature, this beneficial movement will go on.

Of arbitration, the final remedy upon which Mr. Harrah relies for a solution of labor trouble, we have of late heard much, but of a somewhat vague character. We nowhere find a plan of arbitration submitted, and Mr. Harrah does not help us. Under such conditions of feeling as prevailed at Homestead, voluntary arbitration does not offer a satisfactory solution. How shall compulsory arbitration be applied? Shall a workman against whom the arbitrator's decision has been given be compelled, under penalty of the law, to continue at work? Or is it assumed that the decision shall be always in favor of the workman? Shall an employer against whom the arbitrator has decided be compelled to carry on his works against his own conviction that to do so on the arbitrator's terms must involve a continuous loss? And shall he be restrained from changing the investment of his capital after such fashion as he shall choose?

But Mr. Harrah looks to a tribunal of arbitration to prevent and defeat those "infamous conspiracies on the part of employers" wherein it has "too often happened that strikes have been precipitated by the deliberate action of the mill-owners, who, by that means, were enabled to shut down their mills, work off accumulated stocks, and, when ready to start up again, get back their men at lower rates of pay than prevailed before?" A truly Machiavellian policy, except in its unnecessariness. That professor of Mephistophelian wisdom did not inculcate lying for the mere joy of duplicity. Does Mr. Harrah positively know of one such case? What manufacturer whose stock is too large is under such compulsion to continue adding to it that his only refuge is to force a strike?

Mr. Harrah admits that the proposed reforms would not entirely settle the question of the relations between capital and labor, and he brings one more indictment against the employers: "They do not care how the men live after they leave the mill. They do not bother themselves with the social or moral conditions of their families." This seems to me to be a question between man and man, not between employer and employed. To some men, whether employer or workman, it will always be natural to say: "Am I my brother's keeper?" And other men will always esteem it their highest privilege to be afforded an opportunity to serve or help their fellow-men. But these workmen of whom Mr. Harrah speaks are American citizens, freemen, fully capable of looking after themselves after they leave the mill. And their employers, instead of "conceding no rights to the workingman," render him his full right when they recognize his privilege to take care of himself. The attitude of condescension and patronage of the European employer is out of place when it is assumed to an American mechanic, who, as Mr. Harrah says, "would be a poor mechanic if he did not make more than the average preacher and teacher," and whose time, after work is over, is occupied with the details of his building association, his society, or the politics of his ward, and who would look upon any interference on the part of his employer with his social life with much the same feeling with which the employer would regard his workman's inquiry into what he does at his club.

No discussion of the labor troubles and the tariff would be complete without some reference to the farmer, and accordingly we have the "bent back of the farmer"—where, says Mr. Harrah, "eventually all taxes rest"—brought in, in some undefined connection with a "free breakfast table." Mr. Macveagh has it "the bent back of labor," but, leaving these gentlemen to settle the right rendering of the phrase, I simply deny the truth of the assertion in either form. Every one who creates wealth in any way pays a portion of the taxes, and under modern conditions wealth is created in many other ways than upon the primitive basis of the "bent back" of farmer or laborer. As for the farmer's breakfast table, surely no table could be more free than his breakfast table is now. Sugar, tea, and coffee are free here, while Great Britain levies a duty upon them all. The American farmer pays no tax upon his breadstuffs, his meats, or anything else that he ordinarily eats. His plowshares and agricultural implements cost him no more than they cost the English farmer. The wearing apparel of himself and wife cost

so little more that the difference would scarcely buy his yearly supply of smoking tobacco. Foreign-made goods, worn by city people, who insist upon a certain style and finish, cost more, but American goods, as sound in material, as comfortable to wear, and as durable, cost scarcely any more than the same grade of goods cost abroad. Why, then, it may be asked, is the farmer not more prosperous? This is a large question,—too large for this paper. The farmer of free-trade England is not more prosperous. We hear of bad years, of land going out of cultivation, of emigration to America, and our western prairies are full of English farmers who have found in free trade no royal road to prosperity.

I shall not attempt in this short paper to discuss all the causes of modern labor troubles, or the remedies which may be advanced to meet them; but one cause and one remedy are so potent and overshadowing that I cannot forbear to mention them.

The cause is the demoralization of public sentiment. Edmund Burke's words, "You cannot indict a whole people," have passed into current speech and thought, and have been applied in a wider sense than that in which they were meant. Hence it has come to be felt that whatever is done by a sufficient number of people is right, and above and beyond the law. A whole people cannot, indeed, be indicted from within, but that is because of the physical impossibility, not because of the moral law. The law exists, whether or not wrought into precedent or spread upon the statute-books, and in the natural world punishment for its violation is meted out with stern justice whether the offenders be three or three thousand,—one individual who disregards the laws of his being, or a whole community which neglects the laws of sanitation and health. A large number of people can have no rights which a few individuals do not have. Yet it has been gravely argued by men eminent in law and in public affairs that the body of workers at Homestead possessed, apparently by virtue of their numbers, certain rights in their employers' property which, if claimed by the coachman or house-servants of these eminent gentlemen, would have aroused their amazement and scorn. A nation sees with approval, or at least justification, the "leading citizens" of New Orleans marching in defiance of the law, to the jail, to slaughter prisoners who had just been acquitted by the courts after due trial. Is it wonderful that the echoes of New Orleans should be heard in Cœur d'Alene and Homestead, or that other "leading citizens" in other places should hold themselves above the law?

So much for the cause of such outbreaks as that at Homestead. The remedy is to call things by their right names. Let murder be called murder, and crime be called crime. It does not alter the fact, that the murder has been done by a member of a "labor organization," either as an individual or as part of a collective body engaged in carrying out the policy of such an organization. There can be in this country no *imperium in imperio* by which violence, murder, and conspiracy may be licensed, acquire some other character, and be called by some other name. Words are things, and when we use the right words we have made a long step towards a right understanding. Let us have an end of the substitution of some softer and evasive phrase for the violence of a striker who intimidates or assaults a fellow-citizen who chooses to take work on his own terms. Let there be an end of the loose use of such phrases as "robber barons," "tyranny of capital," extortion of employers, "rascality of employers," "tariff robbery," and all the other cant by which demagogues deceive their deluded followers. When we find a man of a different stamp using these phrases for the discussion in public of a serious economic question, let us hold him to a rigid accountability and demand of him the meaning of the words he uses.

If it be true, as Mr. Harrah tells us, that he is a poor mechanic who does not make higher wages than the average preacher and teacher,—and no one who is acquainted with the subject will question the statement,—then obviously there is no reason inherent in the mechanic's means or pecuniary position why he should not live as comfortably, as independently, and with as much self-respect as the teacher, and in as full subordination to the law. We do not hear of teachers banding together to intimidate and assault their fellows, or to burn school-houses, nor is it asked on their behalf that richer individuals shall look after them out of school hours or inquire into their social conditions. The mechanic and the teacher in Mr. Harrah's own city of Philadelphia live side by side in the same row, in houses of the same character, and the mechanic has more money to spend than his neighbor. If he loses his place, he can, more easily than the teacher, find another. Where then is the difference? Do we not take a long step towards the settlement of labor troubles if we can get the workingman to call things by their true names, by means of which he can think more truly and then order his life after the manner of his truer thought?

THE PAN-AMERICAN RAILWAY SURVEYS.

By J. D. Garrison.

THE surveys for the Intercontinental Railway have been in progress nearly eighteen months and are now nearing completion. Of the 3000 miles or more of territory which were to be examined between Mexico and the Peruvian railway system, only a few hundred miles, included between Nicaragua and the Isthmus of Panama, remain to be surveyed. Two parties of engineers are now at work on that reach; and when their lines have been connected, as they will be early in 1893, the entire line of the Intercontinental railway, together with sundry branch lines, will have been gone over with an accurate and elaborate survey. The history of the inception and earlier growth of the project for an Intercontinental railway is familiar to the American people. How the scheme, originating with Colonel Hinton Rowan Helper, was at his instance considered by the Pan-American Congress; how, upon the recommendation of that body, an International Commission was appointed, consisting of representatives from all the American republics, to superintend and direct the surveys and explorations; and how the Commission took up and has since carried on the work assigned to it,—are matters that have been treated from time to time, during the past two years, in various American and foreign journals. Up to the present time, however, very little,

WILLIAM FINDLAY SHUNK.

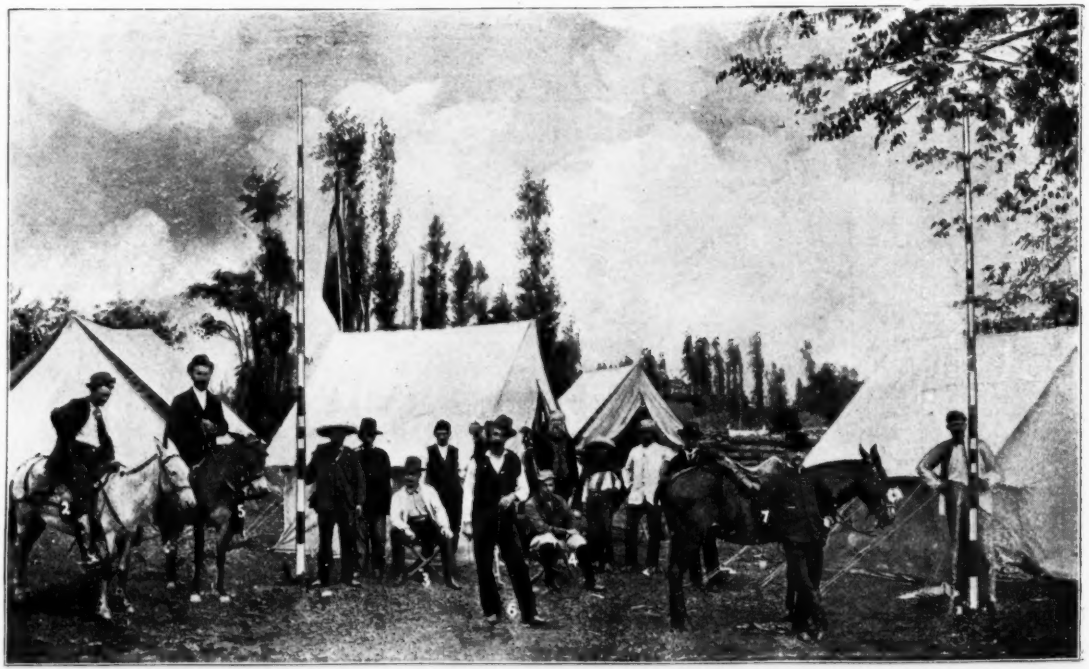
Engineer-in-Charge, Intercontinental Railway Surveys.

if anything, has found its way into print bearing upon the operations in detail of the parties in the field.

When the Commission took up the matter of surveys for the Intercontinental Railway, it organized and sent into the field three corps of engineers. To one of these corps was assigned the duty of making the surveys for the proposed line through Central America from Mexico to the Isthmus of Panama; to another was given the surveys between Quito and the railway system of Peru; while to a third was assigned the work from Quito northward to

THREE GENTLEMEN OF PASTO—OFFICIALS.

the isthmus. These parties acted separately and independently of each other in the field, reporting their operations and results directly to the Commission in Washington. They all followed a general plan, however, prescribed and laid down in advance by the Chief Engineer. A sketch of the operations of one party, therefore, will give an idea of the operations of all. The writer was connected, through the greater part of its surveys, with the party working northward from Quito, and it is here his purpose to outline the labors of that party and its methods of carrying on the work.



CAMP NO. 3—GUAYAQUIL BRIDGE, NEAR MEDELLIN, COLOMBIA.

1. William F. Shunk, Engineer-in-Chief. 2. J. D. Garrison, Principal Assistant. 3. William J. O'Connell, Topographer. 4. Dionisio M. Martinez, Topographer. 5. Thomas F. Dempsey, Assistant Engineer. 6. James Parker, Secretary. 7. Fred. N. Ogden, Medical Officer.

Corps No. 2, as this section was designated, sailed for Guayaquil on April 10, 1891. It arrived at that port some twelve days later, and early in May reached Quito. The corps was in charge of the Chief Engineer in person, Mr. William F. Shunk, of Harrisburg, Pennsylvania. As this corps had to examine what was supposed to be the most difficult portion of the line, known as "The Knot of the Andes," lying between Quito, in Ecuador, and Popayan, in the Republic of Colombia, the Chief Engineer deemed it expedient to accompany it himself and direct its operations. He

CORNER OF PLAZA, IBARRA, ECUADOR.

had associated with him, as assistants, the following: Assistant Engineer, Mr. Robert Burgess, of Missouri, who was afterwards succeeded by the writer; Topographer, Mr. William J. O'Connell, of Washington, D. C.; Junior Assistants, Thomas F. Dempsey, of California, and James Parker, of New York; Surgeon, Dr. F. N. Ogden, United States Navy; General Camp Assistant, Benjamin Caldas, of Quito.

The party was detained some time at Quito by matters of organization and equipment. One of the most important things to be considered at the outset was the question of transportation.

SURVEYORS STARTING TO WORK, RIO GUAITARA, COLOMBIA.

The corps had no small amount of baggage, and in Ecuador, as in all the interior countries of South America, the highways at certain seasons of the year are almost impassable. The only means of carrying cargos over these highways at any time is limited to mules; and mules were hard to buy. The requisite native help was also difficult to obtain. The common people of this section, upon whom the engineers had to depend for such laborers as were needed, rarely venture far from home in their intercourse with each other, and they were naturally averse to joining a party of strangers

CHURCH OF NUESTRA DE LAS LAJAS, LAJAS RIVER, COLOMBIA. BUILT INTO THE HILLSIDE OF ROCK.

going into unknown regions. This aversion on their part was not lessened, nor was the courage of the engineers increased, by vague rumors and traditions set afloat to the effect that beyond the mountains north of Quito lay chasmy solitudes poisoned with malaria, and swarming with insect and animal life through which no human being could pass. It was not, therefore, until June 1 that the party was enabled to begin work. On that date it set its initial stake in the southeastern suburb of Quito and began its march northward.

CHOTA INDIAN VILLAGE, CHOTA VALLEY.

IN THE CRATER OF MOUNT PASTO.

The character of the surveys carried on by the party approximated towards both a reconnaissance and a preliminary instrumental survey. It was at first proposed to combine the method by transit and stadia with that of odometer and barometer, and the party had been equipped with that end in view. But the odometers provided proved to be unsuited to the country; so they were cast aside and the surveys carried on by transit, aided by the barometer.

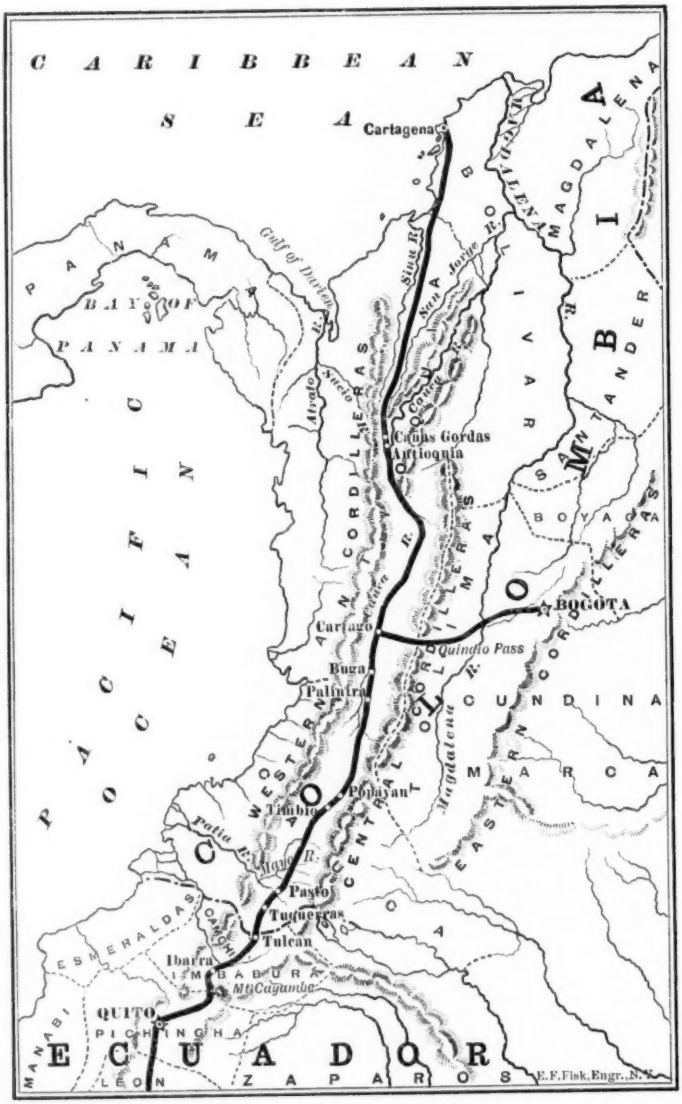
Under this system the Assistant Engineer usually went in advance of the party with the transit, choosing his points and

making his observations from back-sights by means of a stadia rod in the hands of one of the Junior Assistants. The Topographer followed with plane table and compass, taking levels of streams and other intermediate points with an aneroid barometer, and constructing his sheets. The Chief Engineer either accompanied the party or went in advance, at his discretion, with an accurate system of observations by barometers and other instruments, and made such notes as were needed for the proper guidance of the work and for compiling his reports. A few weeks after starting, the party having made the acquisition of an extra Topographer in the person of D. M. Martinez, of Philadelphia, the Chief divided the corps into two sections, taking charge of one himself as transit man.

At the very outset the party encountered rough work, and this lasted as far as Popayan. The line, whether following some one of the interandine valleys or climbing along the sides of precipitous mountain slopes, fell always on tortuous ground that made going difficult Camp-moving necessarily followed the highways, which, in all the distance traversed, kept to the hills, whereas a valley line, when possible, was indicated for the railroad ; and this involved long marches to and from work. Even in the valleys, where good ground and fair going were to be expected, progress was slow. All of the valleys between Quito and Popayan, without exception, are netted with multitudinous watercourses in cañons,—of great depth usually,—impossible to cross except by the traveled ways or by obscure and hazardous paths known only to the Indians.

These cañons, or "quebradas," as they are locally called, whether ten feet deep or five hundred, have invariably a tin-funnel cross-section,—slant above, wall-sided below,—dropping, as a rule, abruptly from the surface to an angle of forty-five degrees, and rounding down to the perpendicular; so that what is to all appearance a trifling ditch usually proves as impassable by horse or foot as a profound chasm. Hence it often happened that the engineers were obliged to make long detours to cross these water-courses; and not infrequently the compass of a mile was made on foot to carry the line to a point ahead within the toss of a biscuit.

From Quito the line followed for some distance the slopes of the Machángara river, which runs northward in a great upland valley lying between the two parallel Cordilleras. From the Machángara it climbed gradually along the base of the Eastern Cordillera, passing under the shadow of Mt. Cayambe,—a huge volcanic mass whose snow-capped peak is the center of eternal



APPROXIMATE MAP, INDICATIVE OF THE PAN-AMERICAN SURVEYS.

storms,—and gained the summit of the Nudo de Cajas on a cross range of mountains uniting the two Cordilleras, and forming the first great knot of the Andes.

From the Nudo de Cajas the line developed around the tributaries of the Toguando by the way of Cochiranqui, to reach the city of Ibarra, 2000 feet below; and from Ibarra it traversed northward the Toguando and Choto valleys, lying in torrid pits of volcanic waste, and greatly infested with troublesome gnats, fleas, and other insects. A few miles south of Tulcan the second knot of the Andes was encountered. This was the great Nudo de Huaca, where a second cross range of mountains united the Cordilleras. It was passed at the Boliche summit by a tunnel one mile long, which brought the line into Tulcan.

Between Tulcan and Pasto the Cordilleras assume their most rugged shape. Tulcan lies upon Guaitara waters, and passage from these waters to those of the Pasto river—upon which Pasto is situated—seemed forbidden by the huge ruined cone of La Galera, and a vast circuit of heights adjacent thereto, rising 15,000 feet above tide. The passage was made within the line, however.

Following the Guaitara river past its junction with the Rio Telles, the line turned up the Guapuscal, following this stream and the Chimbatangua to the village of Tanqua, where it doubled into the Yaruqui. Here another return was made southward, followed by a final one north to the great plains of Yacuanquer, whence a depression in the barrier was gained along the southeastern flank of La Galera. The summit found and used here was hitherto unknown. The Chief, therefore, exercising the right of discovery, named it in memory of a deceased daughter,—in good Catholic Spanish,—"La Cima de Santa Gertrudis."

Having passed La Galera, Pasto was reached without trouble. To get out of it, however, was another question. In order to reach the Patia valley, where it was desired that the line should go, it was necessary to cross the "Profound Valleys" of the Juanambú and the Mayo, both branching off 6000 to 8000 feet vertical in fifteen miles, and separated by a lofty spur of the Eastern Cordillera. To overcome these obstacles, development was made around the upper waters of the Juanambú and a crossing of that stream effected near the town of Tablon, from which point the valley of the Rio Quiña bore the line to a favorable pass on the dividing spur, hitherto unexplored, at its head. Thence a similar development around tributaries of the Mayo brought the survey to a cross-

ing of that stream a few miles north of Las Cruces; and the valley of the Mayo was descended for a distance of ten miles, passing the village of San Pablo. The slopes of the valley beginning to break into rugged, wall-shaped spurs at this point, the line turned through a short tunnel into the valley of the Las Palmas.

The Las Palmas gave entrance to the Patia; but the latter being a wilderness country there, while its main branch, nearly parallel to it, and watered by the Rio Guachicono, is a well settled region, the Guachicono was followed northward to annex it into the upper Patia near the village of Arboles, and a valley line found practicable thence to the vicinity of Timbio on the approach to the Ridge of Roble, a few miles south of Popayan. This ridge forms a watershed between Atlantic and Pacific waters, and is the last obstacle in the "knot of the Andes" going north from Quito. It was passed by a tunnel 600 feet long, which brought the line into the Cauca valley. This valley, 400 miles north of Quito, was entered about December 1, six months after the party began work.

It had been supposed that the Cauca valley would afford "plain sailing," and it had therefore been looked forward to with great eagerness. The vision that greeted the eye of the Patriarch when permitted to look upon the "Promised Land of Canaan" could not have been more beautiful than the panorama spread out before the engineers by the Cauca. All roseate hues vanished, however, when the valley was entered. What seemed at a distance to be plain green expanse was found, on closer examination, to be a swamp tract covered with a thorny growth of cactus, forest underbrush, and matted creepers that almost defied progress of any kind. The drier portions of the valley proper—that is to say, within three or four miles of the river—were found also to be cut and laced with treacherous bayous and overflows, difficult to cross, and harboring myriads of reptiles, mosquitos, sand-flies, and gnats of every description, that proved a terror to man and beast. No engineering difficulties beyond these were encountered, however, and the line, after crossing diagonally from Cali to Palmira, was carried over easy stages and on good railroad ground by way of Tulna, Buga la Grande, Zarza, and Naranjo to Cartago, some 200 miles north of Popayan. At Cartago a liberal examination was made over the Quindio pass towards Bogotà, which city it was proposed to reach by a branch line extending into Venezuela.

Nature's route—and the one indicated by the engineers—follows the Cauca river from Popayan to the city of Antioquia. At this

point it leaves the Cauca, and, turning across the Western Cordillera at the pass near Cañas Gordas, enters the valley of the Sucio, a tributary of the Atrato. An alternate line was also run by the pass of Bolivar to Atrato waters near Quibdo. This line leaves the Cauca river at its junction with the Rio San Juan.

As originally contemplated, the work of Corps No. 2 on the line of the Intercontinental railway proper ended when the corps reached Atrato waters. After that, as laid down in its instructions, it was to make examinations for a branch line into Venezuela. Political disturbances in that country, or other causes, led to a change of programme, however, and it was concluded to make surveys for an inland line, leaving the Cauca at its junction with the Quebrada Sinafaná, and extending by the latter stream and the Rio Porce, by way of Medellin, Higueron, Quebrada Doradas, and Caceres, to a point on the low divide between the San Jorge and Sinu rivers, from which the Rio Sucio might be reached westwardly, and Cartagena, by means of a branch line, northwardly.

These surveys, covering a distance of about 500 miles, were begun early in June, 1892, and finished towards the latter part of August. They were conducted under great difficulties, and made exhaustive drafts upon what vitality remained in the corps after its long march from Quito. The greater part of the distance traversed was along the low lands of the Cauca and Magdalena rivers, the nature of which has hitherto been little known. On this stretch the rains rarely ceased, and poisonous insects, reptiles, and fevers were encountered on every side. The engineers had heard in the interior many unfavorable reports of this reach of country, and, naturally enough, felt a little nervous about entering it. According to generally accepted traditions, none but the old Spanish explorers, or men of like heroic mold, had ever ventured through this tract; and many and direful were the predictions made as to what awaited the corps on its journey. Fortunately all predictions failed. Beyond suffering great hardships and privations, the party met with no mishaps whatever, and the engineers all arrived safely at Cartagena on August 26, 1892, having surveyed upwards of 1400 miles of railroad line.

The personal experiences of the party would fill a book. All conditions were accepted alike with fortitude. The party, in the main, was composed of manly, courageous fellows, strong in will and muscular development, who considered no duty too hazardous to undertake. Even the Chief himself—a veteran in

the service, and grizzled with the weight of sixty years—took share with the "boys," and showed under all circumstances a vigor that was the envy of those of half his age. Living upon the country side,—jerked beef and black beans, and still blacker coffee, the staples,—or dining in state with the governors of Provinces; drenched with chilling rains or scorched by a tropical sun; freezing under Mt. Cayambe or gasping for a breath of fresh air in the low lands of the Magdalena; fighting monkeys and boa-constrictors or swimming alligator-infected streams in the forests of the Cauca,—all things were accepted without murmur and laughed over later.

The question might pertinently be asked: What will be the outcome of the Intercontinental Railway work, now nearly done? The surveys have demonstrated that the line is feasible. On the route indicated by Corps No. 2 it can be constructed at moderate cost. Many and long stretches can be graded very cheaply, and on the heaviest reaches the outlay would not be excessive. The line, too, would be comparatively easy to operate. In no case was a gradient used exceeding 3½ per cent. on tangents, and the curvature required would not exceed that of many roads of heavy traffic in the United States. Whether it would now pay to build the line is another question. The present population of the countries traversed by it and the volume of traffic in sight would certainly not warrant the outlay that would be necessary. But the possibilities of the line would also have to be considered, and these are many. All of the countries of South America are rich in undeveloped resources that only await the building of railroads; and the building of the Intercontinental Railway would be the "open sesame" to all their wealth.

Colombia especially is a country of grand possibilities. It is rich in almost every species of mineral wealth, and its climate and soil are also particularly adapted to agriculture and grazing. In addition to the tropical fruits, nearly all of the fruits and cereals of North America grow there almost without cultivation. The country would be a paradise for the herder and grazer. The valleys, and even the mountains, are green all the year with luxuriant grasses that would support and fatten myriads of cattle. The streams of the country are rich in gold, and mines of incalculable wealth await there the finder. Whether or not the Intercontinental Railway surveys shall lead to the early utilization of these resources, it is worth something to have the knowledge of their existence, which the surveyors have brought to light.

LIQUID FUEL FOR STEAM-MAKING.

By F. R. Hutton, C. E., Ph. D.

THE combustibles which are at the service of the engineer for industrial purposes come to his hands in three forms. The solid fuels are coal and wood, lignite and peat, in their natural or derivative forms; the liquid fuels are petroleum in its crude state or as a product of refining or distillation; and the gaseous fuels are either natural or artificial fuel-gas. The solid fuels are historically the first; the liquid and the gaseous have only come to the industrial importance which they now occupy during the last thirty years.

The combustion of a fuel being a union with oxygen, which is a gas, it is necessary that the fuel, whatever its form, be first reduced to such a fine state of division that it shall be possible for the union to take place rapidly. For the solid fuels there is necessary a certain consumption of energy in the form of heat in bringing about this fine division, either by a process analogous to distillation, by which gas is made, which subsequently unites with oxygen, or else by union with oxygen only on the surface of the solid particles of fuel. In the latter case, from the relative slowness of the combination, the temperature of the flaming furnace is kept at a lower point than where the form and fine state of division of the fuel permit this chemical union at a more rapid rate.

Confining attention to the subject of fuels in a liquid form, it may be stated that the first experiment in this country upon any considerable scale seems to have been made at the Morgan Iron Works, in New York city, in 1865, and is identified with the names of Colonels Foote and Julius W. Adams. The very high price of coal at that time, and the recent large discoveries of petroleum, gave special interest to this series of experiments, although the previous investigations by Professor R. A. Fisher, of New Haven, had shown that the question of the substitution of oil for coal as a fuel was largely if not solely an economic question, affected by the relative cost of the two materials and their accessibility in any locality.

The English experiments of the same period bear date of 1864, under the system of Mr. C. J. Richardson. These were specially

stimulated by the marine interests, with a view to the advantages offered by oil as a fuel on board-ship for strategic and practical reasons, and secondly, by reason of the special problems facing engineers in the colonies, where coal was difficult to obtain for locomotive purposes and where, in the dry season, it was of prime importance that no spark should be discharged from a locomotive-stack to ignite a parched and inflammable vegetation.

In the development of the use of oil as fuel three great classes of furnaces have been put forward. That class in which the oil is introduced to the fire-box in a liquid form embraces four types. The first is that in which the oil is delivered into pans in the fire area, where it is set fire to with the access of what air can be got to it,—a method obviously imperfect, uneconomical, and accompanied with great waste in the form of smoke. In the second form the oil is delivered into grooves upon a step-grate so that it overflows from step to step, meeting the air-supply between levels. This secures a much better union with the air and seems to work well, particularly in metallurgical practise. The third type may be called drop furnaces, where the oil drips from a number of pipes on to the combustion area, and is there ignited. The fourth type introduces the oil as a fluid up from below through a porous bed of lime, or other similar material, at the top of which it meets the air for combustion, and burns as from a wick. This is one of the most satisfactory methods of using the oil as an undivided liquid, but it presents the difficulty that perfect combustion cannot be insured for any great length of time. The heavy constituents of the oil accumulate in the porous layers and gradually interfere with the flow.

The second great system for the combustion of oils involves the principle of finely dividing the oil by means of a jet of air or steam moving at high velocity and forcing the oil in spray form into the fire-box. The burner in all systems of this class is practically an injector, and the steam or air carries the fluid with it usually in an annular jet, and its fine state of division brings it to a condition in which it can combine rapidly and completely with the air necessary for combustion. It will be seen that in this system a subsidiary apparatus must be depended on when the fire is first to be started. There must be a pressure of steam either in the boiler which is being fired or in some other boiler, in order that the steam jet can be started, or else the fire must be started with solid fuel, and the use of oil begun only when the necessary

pressure has been accumulated. Where air is used to bring in the oil, a pump is required to produce the necessary pressure, and for this reason the plan of using steam as the inducing medium is practically the only one which can be used in locomotive service, where subsidiary apparatus must be reduced to its lowest terms. As to the relative advantages of air and steam, when they are equally available, steam would appear to have the advantage over air, in that it is at a higher temperature than air usually is when it enters the nozzle of the burner, and that it does not entrain with it inert matter, such as nitrogen, which has to be heated up by the flame, but does no useful service in the combustion. Moreover, if the temperature of the flame is high enough to dissociate the oxygen and hydrogen which formed the steam, while the heat absorbed in this dissociation is the same as that given out in the combustion of the hydrogen of the steam, the mechanical effect is to increase the proportion of hydrogen in the flaming mass, and thereby to increase the length of the flame, with a consequent gain in its radiating effect. While there is no gain in units of heat, there may be a gain in the efficiency of the flaming mass to transfer its heat to the water in the boiler. On the other hand, there is required for the combustion a certain weight of air, and its introduction with the oil in the jet secures an intimate mixture of this air with the oil favorable to its union with it in combustion, and the specific heat of air is 0.23 while that of steam is 0.48, so that more heat is required to bring the vapor of water up to the temperature of the products of combustion than is required to bring air to the same temperature.

The fact, however, that the steam system requires no air-pump will be a preponderating argument in its favor in many places. For the heating of forges also, the steam would appear to be an inconvenient diluent of the flaming mass.

It would be impossible here to allude in detail to the various forms of burner which have been presented for the use of oil as fuel. There are several features, however, which a good burner must have in order to work satisfactorily. The great difficulty in any form which has its nozzle near enough to the flame to have combustion begin at the very orifice is that the oil will carbonize at the orifice and gradually stop it up, sometimes checking it altogether. The burner must be of such construction that these pasty or hardened accumulations may be easily removed without stopping the apparatus, or else the burner must be fitted in duplicate, so that the one can be used while the other is being cleaned.

The best known injector of this class is that brought out by Mr. Thomas Urquhart, locomotive-superintendent of the Grazi-Tsaritzin railway in southeastern Russia. His arrangement is a steam system, and the nozzle of the injector for oil enters within, but does not pass through, a thimble inserted in the rear water-leg of the locomotive-boiler. The flame does not reach the nozzle of the injector, and the trouble from carbonization or coking of the oil particles is largely eliminated. If this should occur, or if the annular oil-channel should become clogged by any matters in the oil, the steam-tube can be retracted by a screw motion operated from the foot-plate of the engine, and the steam-jet, which is one of the most detergent elements known in the arts, will immediately blow the opening free and clear.

In any of the comminuting systems of this class care must be taken that the flaming particles of oil coming into the fire-box at high velocity from the jet should not impinge upon a particular spot of the heating surface. In all the systems it is aimed to secure this end by interposing in the path of the jet a baffle plate of fire-brick or similar material. In the Urquhart furnace the fire-brick is built up at the front end of the fire-box nearly to the height of the lower row of tubes, and an arch is sprung across from side to side of the fire-box, very much in the position in which the usual arch is found in bituminous fire-boxes, and it is in this blind rampant archway that the intensity of the combustion takes place. This mass of fire-brick becomes white-hot, and serves not only to store and radiate heat, but also to ignite the jet when it is cut off for a stop of the train. An objection to all burners of this class is the noise which they make, but in many places this need not be more objectionable than the noises in many fire-rooms from quenching the ashes by turning a hose jet upon them. It is comparatively easy to prevent annoyance from explosive ignitions of the oil, if the precaution is taken to put into the fire-box a lighted wad of waste of shavings, and, after this, to turn on first the steam, and then the oil, to the burner. Where the fire-chamber can become filled with vapor of oil before the flame is applied, there may be enough carbon ready to combine instantly with oxygen when the flame is applied to cause an explosion, which is always startling and may be dangerous.

The third great system of furnaces for burning oil embraces those in which the oil is first made into a gas and is burned in the fire-box in true gaseous form. This principle was applied in oil-

firing in this country as early as 1867, when a furnace of this sort, devised by Colonel Foote, was tried in the United States gunboat *Palos*. A flat coil of pipe conveying the oil to a larger pipe occupying the place of the bridge wall was brought up to a high heat by the combustion of the oil delivered in burners underneath the coil and in front of the retort. Superheated steam similarly heated by the issuing flame from the burners brought the whole mixture up to a very high temperature, and the products burned as a gas. In this case, of course, the gas and steam streamed out of the burners at a high velocity. The Archer fuel-process is essentially similar in principle, forcing the oil by a pump through a circular coil of pipe, which is kept at a high temperature by an annular fire surrounding the central retort, which, in this system, is called the "thermogen." Steam, in a similar coil, is superheated, enters the thermogen with the gasified oil, and passes with it through the necessary regulating-valves to the furnace of the boiler under which it is to be used. Unlike the vapor systems already mentioned, it enters the furnace at a comparatively low velocity, without the rush and roar characteristic of so many of the other systems, and it is claimed not only that this peculiarity results in the consumption of less oil for a given amount of evaporation, but also that there is avoided the difficulty present in some of the comminuting systems of the formation on the heating surface of an incrustation due to the constituents of the oil which are not thoroughly burned in the fire-box, but are carried forward to be deposited upon the cooler metallic surfaces. The difficulties of the gas system would appear to be those attaching themselves to the use of a retort which either could become clogged from residual matter in the oil, or which would deteriorate from the action of the flame and from expansion at high temperatures.

The advantages which can be urged in favor of the use of liquid fuel are many and important. First, the crude petroleum has a higher calorific power than most of the coals, weight for weight. Where a crude oil can be used from which certain of the burning compounds have not been removed by refining, it is possible to secure a calorific power of 21,000 heat-units, while the calorific power of coal may be put at from 12,000 to 13,000 heat units. This means that one pound of oil is equivalent to one and six-tenths pounds of coal. It is often called one and three-quarters. English experimenters, using a lower calorific power of coal, have obtained results correspondingly more advantageous for oil.

This consideration has a very important bearing in both locomotive and marine service. In the locomotive-tender, if it is possible to diminish the amount of fuel which must be carried between terminals to keep up a given speed or hauling power, the dead load is diminished with consequent obvious gain. But more important still, if there can be burned over a given grate-area a fuel of higher calorific power, it becomes possible to make more speed from a given boiler in a given time, which means that the cylinder capacity can be increased without transgressing the limits of volume of boiler or surface of grate which the conditions of practise in respect to gage and curvature impose upon the designer of such machinery. In marine practise, not only is the ship lightened or the possible length between fueling stations increased, but, by a parity of reasoning, a smaller bulk of boilers can be expected to do a given amount of work.

Outside this fundamental and far-reaching advantage of a high-grade liquid fuel, there are many practical advantages which need only to be enumerated to convince any one of the great convenience which is permitted by the use of liquid fuel. These are:

1. Diminished waste of fuel from the loss of combustible with the ashes and gases. In locomotives there is a loss of fuel through the stack, rated usually at from 10 to 20 per cent., according to the intensity of the draft. This is saved in the use of liquid fuel, besides which there will be no sparks to be taken care of in the smoke-box, if arrested, or to set fire to property, if blown out.

2. A reduction in the cost of labor for handling the fuel, which is two-fold. There is in most plants an expense for handling coal into bunkers and a second handling from the bunkers into the fire-box. The oil handling for both of these steps is mechanical, while with the solid fuels the second step is but rarely so. It is possible, therefore, for one man with oil fuel to take care of many more boilers than with solid fuel.

3. In cities it is a matter of convenience and economy not to provide for the disposal of ashes, which from the solid fuels amount to from 200 to 300 pounds or more to the ton, and, where the plant is large, have to be provided for by special contract outside of the usual facilities offered by the municipal government. There is no flue dust to clog fire-tubes and diminish their efficiency: but this may sometimes be offset by a deposit of oil residuals in them.

4. Where no firing-tools are required less injury is done to the brick-work of fire-boxes, and grate-bars do not deteriorate.

5. Repairs to the brick-work of the ash-pit and the boiler-room floors are diminished, as the tendency to crack when heated by hot cinders and quenched by water is absent.

6. Better regulation of the fire is possible, as the demand for steam may vary. This diminishes losses of heat from blowing off at the safety-valve, which doubtless often amounts to a loss of 5 per cent. or over.

7. The opening of the furnace doors for firing and cleaning is made unnecessary, so that the boiler may be expected to suffer less from unequal expansion and contraction.

8. Where the engine-room is also the boiler-room, the absence of dust and ashes about the machinery is of manifest advantage.

9. The absence of sulphur is favorable to the life of the boiler-plate, and this is especially an advantage where there is moisture in the solid fuel, which permits the formation of an active sulphurous acid, corrosive in its character.

10. The labor of the fireman is made much more agreeable, inasmuch as all the work of cleaning and the strain of standing in front of open furnace-doors are done away with.

11. Aboard ship, on the locomotive, and in cities, it is easier to secure a combustion as nearly smokeless as a due regard for economy will permit. For war purposes smokelessness is a matter of considerable moment, inasmuch as a trailing banner of soft-coal smoke will betray the presence of a steamer otherwise invisible below the horizon. In the locomotive there are no cinders to annoy the travelers or the train-crews.

12. In the contracted fire-rooms of vessels the temperature of the room can be kept lower, and in tropical latitudes the lot of the firemen will be very materially mitigated for this reason, as well as by diminishing the severity of their labor.

13. On shipboard liquid fuel can be stowed in places where solid fuel could not be put.

The disadvantages attached to the use of liquid fuel will differ according to the nature of the oil employed. In this country two forms of oil are presented for fuel use. One is the product of the oil-wells in Pennsylvania and Ohio,—the crude petroleum as it flows from their mouth, sometimes more specifically designated as Lima oil, from the town of that name. In certain cities the limitations imposed by health boards and fire departments preclude the use of this material, and their reasons constitute two objections to be urged against the great bulk of available crude petroleum.

rst of these objections is its inflammability or high flashing point. This means that because of the presence in the oil of light components which distill off in the form of vapor spontaneously, or under agitation, or at very low heats, there will be given off a light hydrocarbon vapor which will form with air a mixture that will ignite explosively when an open flame is brought anywhere near it. This peculiarity has a very important bearing upon the use of crude oil on board-ship, where it would be kept in confined spaces, or in the locomotive, where naked flames are likely to be found around the oil-tank. The second great difficulty with crude oil is its offensive smell, which has a very important effect in limiting its use.

The other form of oil used for fuel is the product of the refining process after the elimination of the naphthas and the kerosene or burning oils from the crude material, which leaves behind about 60 per cent. of the original quantity, having a specific gravity averaging 40° Baume, and a flashing point above the boiling point of water. This obviously is a very much safer form of oil for fuel and is not objected to by fire and insurance corporations, provided only that certain conditions looking towards the safety of the premises in case of accident are complied with. The usual requirements are that the storage-tanks should be of iron with tight covers provided with ventilating pipes and overflows; that the tanks if possible should be underground, and the piping also; and that the main tank, of larger capacity than the distribution tank, from which the oil passes to the burners, should be, if above ground, surrounded with a dike or embankment, enclosing a space large enough to hold the entire contents of the tank.

Oil of this class, having no volatile material remaining, gives off little or no odor, but there has been sacrificed not a little of its calorific power and of its length of flame. It will contain 85 per cent. of fixed carbon and upwards of 13 per cent. of hydrogen in the ordinary run of samples, the balance being oxygen and impurities, so that it will compare in composition with coal of the bituminous class so much used for steam purposes, and will have by no means so much higher a theoretical calorific advantage over the solid fuels.

The disadvantages common to both forms of oil fuel are, where the vapor system is followed, the noise made by the burner, and, in the gaseous system, the sacrifice of part of the fuel efficiency for the distillation of the gas, and in both the air-vapor and the gaseous system the necessity for auxiliary and additional apparatus, with their first and running cost.

It should be kept in mind that the production of coal is much in excess of the present production of oil.

But the final and conclusive argument is the commercial one, as to the relative cost of an equal weight of calorific efficiency in solid and liquid fuels. This calculation may be made to seek the answer in either equivalent price per ton of coal or equivalent price per barrel for oil.

The product of multiplying the weight of oil per gallon in pounds by the number of gallons in a barrel is the number of pounds of oil in a barrel. If this product be multiplied by the ratio in heating effect of one pound of coal to the pound of oil whose calorific power is known, we have a product which can be handled in comparison with the weight of solid fuel in a ton. If we divide the number of pounds in a ton by the product first obtained, and multiply the result by the price of oil per barrel, we get a figure showing what coal must cost per ton in order to be of the same cheapness. On the other hand, if we divide the above product by 2000 or 2240 and multiply the result by the price of coal per ton, we obtain the equivalent price per barrel which oil must cost if it is to be no more expensive than solid fuel. The cost of coal in this second calculation must include the labor and expense of handling the coal and ashes, which will be dispensed with where oil is the fuel, and the price of oil per barrel in the first calculation must similarly be taken as delivered to the consumer and not as its price at the wells.

A calculation made in 1889 by Mr. H. F. J. Porter for the use of oil under the boilers of an extensive steam-plant in New York city showed that at the prices then prevailing for fuel-oil of the quality at that time obtainable 6.7 barrels of oil were equal to a gross ton of coal, and that with the conditions at the plant in question it would be possible to pay $8.17 per long ton of coal, or that the equivalent price of oil was three mills per pound. Readers of this Magazine will have noticed that in the department of Mechanics for August, 1892, it was stated that oil at 2.4 cents would compete with coal at $3.95 per ton, but where coal was $3.10 per ton and oil at $2.25 per gallon, the coal was cheaper. Where the price of coal drops to the neighborhood of $1 to $1.50, oil even at 1.5 cents per gallon is much more costly. An interesting table of comparative values computed by the above method was presented in the lecture by Dr. Dudley above referred to, and will be found in Volume XCVI of the *Journal of the Franklin Institute.*

ELECTRICITY.

Conducted by Franklin L. Pope.

THE year just closed has been one of steady and satisfactory progress and development in the field of the electrical industries, though not distinguished by any especially remarkable discoveries or advances. In the communication of intelligence the most notable achievement without doubt has been the successful establishment of long-distance telephone communication between New York and Chicago. The general public has no conception of the difficulties which have been overcome, the amount of patient research and experiment, and the vast expenditure of money which has made this result possible. In fact its accomplishment has seemed to the ordinary observer little more than a matter of course. The Western Union Telegraph Co. has added 25,000 miles of wire and 600 stations to its enormous existing system, but has apparently introduced no innovations of importance in its methods of doing business. A striking feature of the past year has been the increase in the number and fatality of railway accidents, a large proportion of which have apparently been due primarily to defective and inefficient telegraphic service. The numerous reports of strikes among the railway telegraphers during the last half of the year have made it but too plain that the important work of directing the movement of trains is largely entrusted to operators who are too young and too inadequately paid, and who are too often destitute of any proper sense of the responsibilities of their position. On the other hand, it is gratifying to record that the introduction of the automatic and other electrically-operated block-signals, and the extension of such systems where already introduced, is going on more rapidly than ever before,—a circumstance which cannot but add materially to the safety of travelers upon many of our most crowded railways. Perhaps the greatest practical advances of the year have been made in the art of transmission of power from natural sources to points more or less distant for commercial and manufacturing purposes. A large number of such power-plants, some of no considerable magnitude, have been installed in this country and in Europe, and apparently in all cases have given satisfactory results. The work at Niagara Falls, the first section of which is now approaching completion, easily takes the lead of all other projects of this kind now in progress in any part of the world, and will furnish, when fully completed, an aggregate amount of power, available for manufacturing purposes, equaling if not exceeding the aggregate amount of steam- and water-power in use in all the industries of the United States, as reported by the census of 1880. The electric street-railway motor-car has made vast strides during the year, both on existing lines and on new lines, which have only been rendered commercially practicable by the employment of the electric motor. The success of electric propulsion in this particular field has naturally led to a number of more or less ambitious attempts to supersede the steam-locomotive on suburban and other lines of moderate length. A far more important scheme of this kind, which has perhaps received in the columns of the public press more notice than its intrinsic merits entitle it to, is the projected electric railway between Chicago and St. Louis. The peculiar means which have been employed to exploit this enterprise; the evident desire and intention of the authors of its prospectus to take advantage of the illimitable credulity of the small investor as to the possibilities of electricity; the fact that the name of no electrical engineer of experience and reputation has yet appeared in connection with it,—can but engender a strong suspicion that it is a stock-jobbing enterprise. Very little progress appears to

have been made during the year in the commercial application of storage batteries to electric traction. One or two new lines have been established, and one or two old ones discontinued, but the net result is not thus far encouraging. The outcome of these experiments was well summed up in the statement of President Whitney, of the West End Co. of Boston, who informed a delegation of his fellow-citizens that, if they preferred to pay ten cents to ride to Cambridge on a storage-battery car, rather than five cents to ride on a trolley-car, it might be possible for his company to meet their views. The number of incandescent lamps in use, and the area of territory served by the illuminating companies, have both been materially increased during the past year, although the rate of progress has perhaps been considerably less than had been anticipated. There is an underlying reason for this state of affairs which is making itself more and more apparent, —namely, that the cost of producing the electric light has been seriously underestimated. Out of the 1500 or more electric central-stations in the United States, comparatively few are earning more than 5 per cent. on their capital and providing for depreciation. The fact that the bulk of the work must be done in four or five hours out of the twenty-four, and that the plant must lie idle the remainder of the time, does not seem to have been adequately appreciated, and the scale of charges to consumers has in many cases been fixed too low,—a mistake not easily remedied after once having been made. It is reasonable to expect, however, that the progress of discovery and invention will gradually ameliorate the present condition of affairs by increasing the efficiency of the apparatus, especially of the lamp, and thus materially diminish the cost of production.

By a decision of the United States Circuit Court of Appeals in December, the litigation which has been going on for a number of years over Edison's incandescent-lamp patent has virtually been brought to a conclusion. The gist of the decision is that the injunction order referred to in these notes for November, which was appealed from by the defendants, must be modified to embrace only lamps infringing a single claim of the patent, and the right is reserved to the defendant to apply hereafter for the vacation, suspension, or modification of the injunction upon proof of specific instances of a refusal by the owners of the patent to supply lamps upon reasonable terms to the owners of electric-light plants installed prior to the rendition of the decree in the Circuit Court. There are now about thirty concerns engaged in the manufacture of incandescent lamps in this country, some of which are of very large capacity. It is stated that immediate proceedings will be taken against these. Unless it should turn out that the new lamp of the Westinghouse company is outside the claim of the Edison patent, this decree gives its owners an absolute monopoly of the manufacture of incandescent lamps until the expiration of the patent. It is not considered probable that the cost of lamps to the consumer will be materially increased by reason of the decision.

In the western portion of the United States the electric railway has become the most potent factor in the growth and development of every aspiring city. Facility and cheapness of intercommunication, next to favorable situation, are more important in this aspect than anything else. The conservatism which is characteristic of old and long-established communities permits the newer ones to supply themselves with modern conveniences and innovations, which, however vital to their growth, the former will have none of. The blockade in Boston, for example, which was temporarily relieved by the introduction of electric cars, is now worse than ever, owing to the increase of travel due to better facilities. It has become, in short, not a question of rapid transit, but of any transit at all, even on foot, in the busy hours of the day. Apparently nothing can relieve the situation except a line carried across the Common, either overhead or in tunnel. But Boston conservatism stands aghast at the idea of such a desecration of the sacred pleasure-ground.

We share the feeling, but nevertheless what is inevitable must come to pass. The situation is fast becoming intolerable.

THE *Manufacturers' Gazette* points out the urgent necessity of immediate protection of the forests at the head-waters of the great rivers of New England, for the preservation of the water-powers, which the general introduction of electricity as a distributing agent is likely to enhance in industrial value. A well-known engineer computes that more than 1,000,000 available horse-power is daily running to waste in the great rivers which flow seaward from the granite hills of New England.

DR. F. PETERSON and Mr. A. E. Kennelly have made some exceedingly interesting physiological experiments with powerful magnetic fields. With a field having an intensity of as much as 2000 c. g. s. lines per square centimeter, it was found that no appreciable effect could be produced upon the human organism. Neither direct nor reversed magnetism, however intense, was found to exert any perceptible influence upon the iron in the blood, upon the circulation, upon ciliary or protoplasmic movement, upon sensory or motor nerves, or upon the brain. The fact that these negative results are what might have been expected does not make them any the less extraordinary.

THE Journal of the Electrical Society of Tokyo (Japan) is certainly a unique publication. It is difficult to imagine anything more funny in appearance than are mathematical formulæ set in English characters, standing on end in vertical columns, in intimate relation with and surrounded by those peculiar ideaographs which to the youthful mind are inseparably associated with tea-chests. Our readers may be interested to know that the Japanese sign for a dynamo resembles nothing so much as one of the music-stands used in the orchestra of a theater. However, as the publication has already reached its ninth volume, we are perhaps not warranted in treating it with a degree of levity which in all probability arises solely from our ignorance, and trust that our Japanese readers will accept our apologies.

THE pranks of lightning in connection with street-railway apparatus are peculiarly vexatious. One peculiarity is that the "fluid" always seeks to strike at the very heart of the system, the station-generator, and if it succeeds in disabling this, the entire service is brought to a standstill. In some parts of the country, when a violent thunderstorm makes its appearance, it is a common practice to shut down the dynamo, remove the trolleys from the wires, and await with as much patience as may be the subsidence of the disturbance. It is stated that on one line, where an account has been kept, the loss of revenue due to compulsory stoppages during thunderstorms amounts to over $6000 per year. An ingenious form of lightning-arrester recently devised to overcome this difficulty consists of a coil of wire inserted in the main circuit and fitted with a number of discharging circuits connected at different points throughout the coil, leading to electrodes immersed in a tank of running water in electrical connection with the earth.

AN experienced central-station manager, writing to the *Electrical Engineer*, observes that the majority of central stations now existing in the United States have not creditably withstood the test of time, and thinks that no small number of them must inevitably be largely improved, reconstructed, or abandoned at no distant day. This unfortunate condition of affairs is not wholly chargeable to the construction engineer; in too many cases the directors, being commercial men unacquainted with electrical matters, have insisted, in spite of advice to the contrary, on employing cheap and therefore unskilful or inexperienced men. As there is scarcely any known industry in which ignorance is so expensive as in construction and management of electric light-and-power plants, it has taken but a comparatively short time to realize the disastrous financial results of such an unwise policy. The margin of profit in electric-lighting is not

large at best, being limited in one direction by the competition of kerosene, gas, and other illuminants already in possession of the field, and in the other direction by the market price of coal. This renders it of vital importance that no mistakes be made either in engineering or in management, if any tangible profits are to be realized. Our observation has confirmed us in the opinion that the highest percentage of loss from bad engineering and management occurs in the smaller central-station plants, where it can least be afforded. If some well-qualified expert would undertake to make a special business of inspecting and pointing out remediable defects in these small plants for a moderate fee, we should think he might be able to build up for himself a profitable business in a short time.

ONE of the most attractive features of the electric display at the World's Fair will be the electrically-illuminated fountains, of which there are to be two, each supplied by a 24-inch water-main. The exquisitely beautiful effects produced by these fountains will be remembered by all visitors to the Paris exhibition of 1889. It is believed that these will be far surpassed not merely in size, but in artistic effect, by the efforts of the Chicago electricians. The elevated railway which encircles the grounds of the Columbian Exposition for conveying visitors from one section to another will be by no means an unimportant piece of engineering. It is to have a double track, and will be operated by electricity throughout. The rolling-stock will consist of eighteen trains of three cars each, which will be run at the rate of about thirty-five miles per hour. The power-house will contain five electric generators, varying in capacity from 250 to 1200 kilowatts, and driven by steam-engines aggregating no less than 4650 horse-power.

AN insurance expert, in a letter to the *Electrical Engineer*, tells of an alleged "electrical engineer" who fitted up one of the finest residences of New York city, employing the cheapest possible grade of insulated wire under the floors and within the walls, while at all the outlets, where the wires were exposed to casual view, a short piece of insulation of superior quality was used. It is a satisfaction to be told that the underwriter's inspector detected this fraud, and compelled the contractor to rewire the building, but it would have been an additional satisfaction if the name of the alleged "engineer" had been made public.

ELECTRICITY has been successfully applied in agricultural operations at the Polytechnic Institute of Alabama, at which place a motor has been at work since last spring, threshing oats, wheat, rye, and barley, cutting ensilage, grinding corn, and ginning and pressing cotton. And this is going on in a State where less than fifty years ago hundreds of miles of telegraph lines were destroyed by a mob of farmers, because the wires were supposed to have superinduced a distressing drought which occurred shortly after their erection. Verily, the world moves.

WORK has been commenced on the power-station for the Eastern district of the Brooklyn City Electric railroad. It is located at the foot of Division avenue, on the water front, and will have a capacity of 12,000 horse-power. It is expected that the power-house of the Atlantic-avenue company will be finished by February, when that line will immediately go into operation.

IN a recent paper read before an engineering society in London, Dr. John Hopkinson took occasion to point out some of the obstacles in the way of carrying on electric-lighting at a profit as compared with gas-lighting. He shows that the cost of being ready to supply 40,000 lights at any moment throughout the year would be £28,010, whereas the cost of actually supplying the amount of current required continuously throughout the year would be £59,250. Again, the cost of a gas-holder, such as that now being constructed in Manchester, of 7,000,000 cubic feet capacity, is about £60,000, while storage batteries capable of containing electrical energy to yield an equivalent amount of light

would cost £280,000, to say nothing of the cost of renewals and repairs.

MOST of the small electric motors used in our large cities, and deriving their supply of current from the electric-light wires, are run at a potential of either 110 or 220 volts. While the economical advantages of a higher pressure have been recognized, there has been some doubt whether the motors would give as satisfactory and uninterrupted service under such conditions as they do at the lower voltage. The problem has been boldly grappled by an electric-power company in Portland, Oregon, whose station is three miles from the center of distribution. Some 700 horse-power of motors are now run at a potential of 500 volts, with results which are entirely satisfactory. This matter is of more importance than would appear at a casual glance. Excellent and efficient motors, even in the smaller sizes, are now obtainable, and the resulting economy of copper in the lines is very great. Five to ten cents per horse-power hour is the price usually obtained for current furnished to such motors, a price which yields a good profit when the motors are run in connection with a lighting station.

THE annual report of the Postmaster-General again calls attention to the urgent need of some better means for expediting the transfer of mails in large cities, and says that a pneumatic-tube experiment, now in progress in Philadelphia, is expected to show results which will justify Congress in providing for its adoption in New York, Chicago, Philadelphia, and other cities. It is difficult to imagine why there should be needed any more "experimenting" with pneumatic-despatch systems, whose utter inadequacy for operations requiring a tube of any considerable diameter has been conclusively demonstrated. We have no doubt that parties can be found who will gladly contract to construct, maintain, and operate an electric despatch for mail matter, of any required length or carrying capacity, at a figure far below any proposition which can be made for a pneumatic service of equal capacity. It does not necessarily follow that because the pneumatic system has done good service as a cash-carrier in the Postmaster-General's big store, it is also the best method of transporting mail matter by the ton.

MR. W. FINN, who has devoted much attention to the study of the effects of cosmical electric currents upon telegraph lines, in a recent communication to the electrical journals, calls the attention of telegraphic operators to the importance of making certain observations in connection with these phenomena, especially of the manifestations usually known as auroral currents. He would have them note especially the times of the appearance and disappearance of the currents, and the periods of maximum intensity; the potential differences between the earth terminals of the circuits affected, and the geographical direction of the circuits most affected and least affected by the auroral currents. A collection of such facts from all parts of the world would certainly afford data for a much more satisfactory study of these phenomena than has been possible hitherto, and the wide extent of the earth's surface traversed by the lines of such an organization as the Western Union Telegraph Company would largely enhance the value of any observations which might be made by its employés.

A COMPILATION of the results of the working of a number of central stations in England and Germany shows that the maximum demand for current at any given moment never exceeds 75 per cent. and rarely 60 per cent. of the maximum possible supply, and that the largest daily output is only in exceptional instances equivalent to more than five hours run of the machinery at full load.

THE contract for the incandescent lighting of the buildings and grounds of the World's Columbian Exposition calls for 92,000 lamps. It is estimated that 15,000,000 feet of insulated wire will be required to effect the distribution.

MECHANICS

Conducted by Leicester Allen.

A LARGE decrease of accidents, it is said, has resulted from a law in Germany relating to shops and factories in which machines are used. Under this law the maiming of a workman entails upon the proprietor the payment of doctors' bills, a life-pension to the employé in case of permanent disability resulting from the accident, or, in case death results, a pension to the family of the deceased. The effect of the law has been the general discharge of careless help, and the shielding of such parts of machines as are ordinarily dangerous when left exposed; and these measures are stated to have produced a remarkable diminution of casualties in the use of machines. It would be wise, in the absence of such a law in this country, for proprietors to instruct superintendents and foremen that carelessness on the part of workmen as to their personal safety will be immediately punished by suspension or discharge. More accidents result from heedlessness and recklessness, on the part of employés, than from all other causes combined. It is probably no mistake to attribute the decrease of accidents in German work-shops more to the elimination of careless operatives than to the boxing-in of the dangerous parts of machines.

AN argument in favor of narrower propeller-blades for steamships is found by *The Engineer* (New York) in the condition of a propeller—diameter ten feet—examined after five or six months' continual voyaging to the Mediterranean sea. The paper quoted says that on this propeller "a portion of the leading edge of each blade was clean scoured, a part was covered with marine growth some inches long; while a part on the after edge had a short growth, the greater part of the back of the blade was covered with grass." *The Engineer* justly regards this as evidence that only a small part of the blade was effective. Considering how long and extensively the screw-propeller has been employed for marine propulsion, it might, at first thought, seem remarkable that so little is known of the precise nature of its action under water; but when the difficulty (not to say impossibility) of actual observation is taken into account, it is not so much to be wondered at. No theory of propeller action has yet been framed that can be relied upon as taking fully into account all the conditions dependent upon various forms of hulls, rates of speed, and position with reference to the hulls of vessels; and it is a well-known fact that, to get the best results from engines of a given power, it is frequently necessary to try one propeller after another until the one best fitted for use with a particular ship is found by actual experiment,—examples of cases where mere theorizing utterly fails to guide selection. So we are still in the dark upon the subject, and though, doubtless, gaining a little light as time progresses, it is likely to be some time yet before a screw-propeller can be selected in advance, for a particular ship, with the certainty that it will prove the best possible when the trial-trip is made.

OF screw-propellers something has been printed editorially in *The Engineer* (London), since the preceding paragraph was written. The topic is the limits of improvement yet possible in screw-propellers. It is obvious that no form of propeller-blade or modification of the boss to which these blades are attached —no reduction or increase of the number or particular arrangement of the blades —can enable a screw-propeller to develop even theoretically a mechanical power in thrust any greater than that developed by the engines that drive it. Practically every one admits that the power of the

thrust in foot-pounds must be less than the power developed by the motors, by the total power expended in overcoming passive resistances. How much less is it in present practice? The editorial referred to makes the point that the limit of improvement must lie within the present margin of loss of power as developed in thrust, and the unavoidable loss in engine friction that experience and skill has not been able to reduce below from 10 to 12 per cent. We may therefore place the theoretical limit of the power possible to be represented by the thrust of the propeller, or, more appropriately speaking, the net work applied by the screw to actual propulsion, as about 88 per cent. of the power developed by the engines driving it. Now, upon this point *The Engineer* asserts "it may be taken as proved that about 80 per cent. of the quality of a screw is fixed by blade area, so that, given blade area enough and regarding 100 as representing perfection, the worst screw it is possible to make will not be 20 per cent. worse than the best." Here then, if the proposition made be accepted as true, we have the limits between present practice and theoretical possibility cut down to 20 per cent. of the total theoretical possibility. It is to be doubted whether all marine engineers, or perhaps a majority of them, will accept the proposition without challenge. It is certain that in practice there are anomalous peculiarities in the action of propellers. For instance, on one of the English warships a great variety of propellers were tried before the propulsive power developed could be made satisfactorily commensurate with the power of her engines; and when this result, after tedious experiment and much expense, was at last secured, no one could say with certainty why the successful screw was more efficient than others that were tried and found wanting. *The Engineer*, in the course of its long argument, quotes from text-books that "the efficiency of the propeller is 50 or 60 per cent," and upon this remarks that "unless very serious mistakes are to be risked, it is necessary that in all cases the sense in which the word 'efficiency' is employed shall be very sharply defined." Mr. Isherwood's definition (thrust multiplied into speed of the ship and compared with the indicated horse-power) it thinks misleading to the last degree; however, it admits that "no one seems able to devise a better measure of efficiency," all of which is confirmatory of the meager knowledge of the exact nature of the action of a screw in a fluid medium alluded to in the preceding paragraph.

THE Jackson Sharpe Co., of Wilmington, Del., are going to make an interesting and important transportation exhibit at the coming World's Fair in Chicago. They will place and operate on the intramural railway sixty-five of their open passenger cars, eighteen of which will be propelled by electric motors. Electrical appliances for transportation purposes will play a part in the Columbian Exposition never before enacted at any great international exhibit of the world's progress in the mechanic arts. A very large number of these appliances are of recent origin and will, so to speak, make their debut before the largest gathering of scientific and mechanical experts that have ever yet come together. Such an ordeal must help largely in determining public opinion as to the future of electricity in transportation.

AS to applications of electricity in other mechanical arts, the exhibition cannot fail to be instructive in the highest degree. Among the most important of these applications, for which ultimately a most extensive adoption may be confidently predicted, is the substitution of electric motors for ordinary shafting and belting in manufacturing establishments. One of the most notable exemplifications of this new departure may be seen in the shops of the De La Vergne Refrigerating Machine Co. in New York city. This instalment has recently been made. Full results as to economy and convenience cannot yet be obtained. Enough is known, however, to warrant the opinion that the use of local and special electric motors for driving separate machines is a step in marked advance from the old system of taking power for these machines by belt from line shaft-

ing and countershafting. A personal inspection of this plant impresses one immediately with the absence of the usual maze of pulleys and belting overhead and the greater facility with which traveling cranes can be placed and worked for handling heavy parts of machines. In the erecting shop of the works in question, for instance, a powerful and well-designed traveling crane extends the entire width of the shop. This crane has neither rope-driving mechanism, nor belts and pulleys to move it from one end of the shop to the other, nor for the transverse movement of the hoisting mechanism on its ways, nor for the operation of this mechanism in hoisting or lowering weights. All these operations are performed by electric motor power, and are controlled with great ease by a man who rides on the crane. The large machine-tools are also driven each by its own special electric motor, and all the paraphernalia of countershafts, pulleys, belts, and belt-shippers are absent. The machines are stopped or started by simply stopping or starting the motors. When not running, there is an absolute cessation of expense for power. Each is independent of any and all other machines. No interruption of work on any machine due to the breaking of the main driving-belt or of a countershaft-belt can occur. There is no overhead oiling required, and it is easier to maintain cleanliness. There is no obscuration by shadows cast by overhead shafting, pulleys, and belts. The aspect of the entire instalment is that of extreme comfort and convenience. So far the able superintendent of the works, Mr. E. V. Clemens, is confident that a material saving in cost of power has resulted from the adoption of the system, to say nothing of the more obvious advantages named above. As these works are notable for their extent and for their skilful management, the employment of the system may almost be considered as marking signally the beginning of a new era in machine-shop practice. The handling of parts, and the driving of tools for the manufacture of the ponderous, yet gracefully-designed and highly-finished machines turned out in great numbers by this establishment, put the system to a crucial test, and cannot fail to develop all its merits and demerits satisfactorily within a comparatively short period.

THE strength of small chains—that is to say, of chains the links of which are of metal, ranging from ⅜ inch downward—has always been a matter of uncertainty with engineers. For various reasons chains of this character are not often found to have a strength commensurate with the size and tensile strength of the metal from which they are made. Very large quantities of such chains are, however, made and used annually for hanging horizontal runs of steam-pipes and divers other purposes in the mechanical arts. Hence any reliable tests are important that serve to show how much small chains may be depended upon to support. Such a series of tests has been carried out recently at the Walker Engineering Laboratory in England with English single-jack chain, English double-jack chain, English welded chain, and American "Triumph" chain, the tabulated results having been presented in a paper read by Professor H. S. Hele-Shaw, M. Inst. C. E., before the British Association at its last meeting. The figures given are too voluminous for reproduction here, and only some prominent features of the results can be named. English single-jack chain, diameter 0.036 inch, had an average strength of seven pounds; that of 0.103 inch diameter averaged 93 pounds; and that of 0.25 inch diameter sustained an average weight of 377 pounds. English double-jack chain averaged for 0.038 inch diameter 17 pounds, for 0.1 inch diameter 156 pounds, and for 0.22 inch diameter 790 pounds. English welded chain averaged for 0.127 inch diameter 539 pounds, and for 0.223 inch diameter 1991 pounds. A large number of other sizes was examined by the same tests, as well as a number of miscellaneous chains; but the most notable results were attained with the "Triumph" chain of American manufacture, in which chain of 0.12 inch diameter sustained an average strain of 1295 pounds, and that of 0.22 an average of 3773 pounds, being a strength of about

twice that of the best English welded chain for the same sizes. The English welded chains and the jack chains gave way, under strain, nearly always at the joints; whereas the American chains broke the material itself where it had not been joined, thus realizing the full tensile strength of the material.

SPONGY castings in the manufacture of air-compressors and of pumps for condensing ammonia continue to give trouble to manufacturers, and he who will supply a sure way of overcoming this difficulty at reasonable cost will confer a lasting benefit upon the art of iron-founding. This assertion will quite probably be met with the question: "Why do not iron-founders use aluminum in the metal, the effect of which is asserted to be a remarkable homogeneity and imperviousness, when a small quantity is added to the molten metal?" The answer is that a great many have been discouraged by their experiments in this direction. The experience of one large firm may be cited as an example of the anomalies met with. They purchased a quantity of ferro-aluminum alloy, and, using it "as directed," at first thought they were getting better castings. Then they had a run of bad luck again, and discontinued the use of the alloy as not being of any use. They then, after a time, began to get better, though still unsatisfactory, castings; and resolved to give the ferro-aluminum another trial in the hope of securing further improvement.

Again they thought there was a slight change for the better in the castings; but being uncertain, one of the firm began supplying surreptitiously, on alternate days, first the ferro-aluminum, and next a piece of ordinary cast iron. All agreed that there was improvement in the castings, both on the days when the alleged ameliorating metal was put in, and on the days when the neutral metal was used. Then the cat was let out of the bag, and the use of the alloy discontinued. The castings continued to turn out fairly well for a time; then came another turn of ill luck, if ill luck it may be called, the result being the conclusion that, if ferro-aluminum is of any value in foundry practice, it can only be made so by connecting a chemical laboratory with the foundry, and determining by analysis, from day to day, the exact quality of the metal before adding the ameliorator. Others, of whom may be quoted Mr. L. E. Dunham, of Ashland, Wis., have had a more felicitous experience. In a letter to the *Iron Age*, under date of October 25, 1892, he states that he experimented with samples of iron that made entirely white castings, "so hard and brittle that no tool would touch them." Ferro-aluminum containing 10 per cent. aluminum was used by Mr. Dunham, who describes results as follows: "Two ounces of this in small fragments was placed in the bottom of the heated ladle, and about ten pounds of metal allowed to run into the ladle upon it. It melted quickly and appeared to be diffused uniformly through the molten metal. Bars from this metal were entirely gray, and it could be easily machined, the metal being very tough and close-grained; while the castings from the remainder of the heat were entirely made up of white, hard, brittle iron." Mr. Dunham thinks the ameliorating effect is due to the conversion of the combined carbon into graphitic carbon, and adds that by the use of "enough of the alloy to give about 1 per cent. aluminum in the iron," it will produce additional softness in metal that has a tendency to be hard, and lessen shrinkage. These two widely-divergent experiences, the one given personally to the writer, and the other extracted from the letter of Mr. Dunham in the *Iron Age*, show that the effect of aluminum in cast iron is yet so far an unknown quantity that founders are justified in skepticism regarding the great claims made for it. It would also seem that uniformity of action can only be expected with reasonable uniformity in the quality of the iron melted. It may be, after all, that upon the impurity or otherwise of the aluminum used much more depends than has hitherto been suspected. However this may be, the fact that very excellent results, such as described by Mr. Dunham, have been often obtained is well attested. The other fact that results are

as often or oftener either nil, or so near it as to discourage the use of alumina with many manufacturers, is equally well attested; and it leads to the conclusion that there is yet a good deal to learn regarding the effects of this metal when added to iron in the molten state.

SPEAKING of "directions for use" leads to a thought or two upon a fault in the catalogues and descriptive circulars issued by manufacturers containing such directions. This fault is in a too frequent omission to state reasons for using or doing things which do not obviously show a reason for their use. The mechanical mind is always a reasoning mind, made so by the every-day demand upon it for finding out causes for defects and supplying remedies for them. It insults the reason of such men to demand arbitrarily, and as a condition of success, that some material out of ordinary use for analogous purposes, or some mode of proceeding out of the common in the management of machines or appliances, must be used, or followed, without also stating *why* such material or method is essential. Without this any self-respecting man is apt (such is human nature) to say: "If this material or method be only a matter of mechanical judgment, I see not why I should trust the judgment of another any more than my own"; and he will, not unnaturally, be likely to take his own course regardless of directions. If, by this action, the machine or appliance comes to grief, and the manufacturer of the article throws the onus of the failure upon the user, the latter may, with some justice, retort that, if his common sense had been appealed to in the first instance by some rational explanation of requirements, he would have better appreciated their importance and not looked upon them as perhaps the cranky notions of a visionary inventor. It is to the interest of every manufacturer of any material, machine, or appliance used in the mechanic arts that what he makes shall give satisfaction in use. If a little more elaboration in circulars and catalogues would act as a preventive of neglect in particulars which the maker knows to be essential to good work, it is certainly foolish to ignore this advantage.

A NEW material called "wire glass," for the manufacture of which a company has been formed in Philadelphia, is announced. Various applications of this unique material in the mechanic arts suggest themselves; but doubtless it will find its chief applications in building, particularly in glass roofing and for lighting vaults under pavements. The material consists of sheets of glass formed on a foundation of wire meshwork; that is to say, the wire foundation is imbedded in the body of the glass, imparting, it is said, such a remarkable degree of strength as to take the point from the old adage that "people who live in glass houses must not throw stones." Sheets of wire glass are asserted not only to be hail-proof, but it is also claimed that it is an excellent fire-proofing material; for, although under the action of heat the glass cracks at first, the wire foundation holds it up firmly nevertheless, and further action of heat causing partial fusion again cements it together, heat thus healing all the wounds it has inflicted. Doubtless there may be some element of enthusiastic over-statement in all that is claimed for wire-glass, which remains for time and use to tone down; but the fact that the invention has inspired sufficient confidence in the minds of capitalists to induce them to back it and to erect extensive works for its manufacture is *prima facie* evidence that there is value in the innovation. An additional confirmation that also indicates a very important application of the material is that after examination by Government officials wire glass has been ordered to be used for the new United States war-ships now in process of construction. It is easy to see how this material will withstand the shocks from impact of projectiles that would shatter ordinary glass into fragments. The *Metal Worker* asserts in its issue for December 3 that the Pennsylvania Railroad Co. have given the manufacturers an order for 200,000 feet of this glass for use on the roof of their new train-shed at the Broad-street station in Philadelphia.

ARCHITECTURE.

Conducted by Barr Ferree.

THERE is no more striking way of illustrating the place architecture holds in current life than making a comparative study of the history of a great city, which will extend from the time of its birth to the present day. Life, manners, customs, methods of construction, material, resources, the relative civilization of the builders, with their thoughts, ideas, and conceptions, come out in such a study in an impressive and striking manner. Of few cities would such a study be more interesting than of London, and few writers were better equipped for this task than Mr. Walter Besant,* while as few would have accomplished the work in a more polished or delightful manner. It is a significant fact, and one this book impresses upon the reader more than any other, that a great city of any time or country is never really made or finished, but that the work of building, of taking down old structures and putting up new ones, of transforming localities, and smoothing away the errors and omissions of earlier men, is continually in progress. We may trace periods in a city's growth, as Mr. Besant does for London, but viewed from our modern standpoint these periods merge into one another. The city is never done. It may, at one time, seem thoroughly typical of one era or of one style of building, but this represents the culmination of a change, not its finality. But the lesson taught by such a retrospective glance is not limited to the ceaseless change it suggests. A view of the architectural history of any old city helps very materially to emphasize the adaptability of the architecture of one period to the life and times in which it was produced. Mr. Besant is inclined to describe Plantagenet London as largely a city of palaces,—at all events, not a city of mean and squalid hovels, such as a mediæval city ordinarily is taken to have been. In a measure he may be right, for the London of that epoch included many stately mansions and imposing palaces. The nobility lived luxurious lives, and did not stint themselves in purchasing all the conveniences and necessities they knew of. It is likely enough that this gay, rich life was lived in a sufficiently large number of dwellings of imposing extent to give a definite character to certain parts of the city, just as to-day the dwellings of the rich,—less imposing and less magnificent than in that distant time,—give character to portions of modern towns. But with all this the homes of the laboring men, the abiding places of the poor, form the bulk of the buildings of any great city. Their outward forms change with time, but morally and politically there is little change. The student of municipal growth should not fail to read Mr. Besant's beautiful volume.

APPARENTLY the fire-insurance companies are awakening to the fact that they have it in their power to materially lessen the dangers from improper construction, old buildings, and similar nuisances and imperfections, which every year have destroyed as much architecture in America as investors and owners have put into it in the shape of new buildings. In the abscence of any national building law, in itself hardly a possibility, in the absence of generally satisfactory and efficient administration of local laws, or the total omission of such laws altogether, it would seem only a matter of ordinary business sagacity for the insurance companies to take the regulation of such things into their own hands. Unfortunately, competition in insurance, as in some other matters, sometimes renders uniform concerted action impossible, but a new state of affairs seems coming, judging by the conference of insurance men in New York city in Decem-

* *London*. By Walter Besant. New York: Harper & Brothers, 1892.

ber, looking towards uniform results. The work of this meeting was wholly preliminary, the results of its labors having to be approved by the companies themselves before they become operative.

FEW questions are of so much importance to architects and architecture as the relations engineers bear to the profession and the art. On the one side a large body of men maintains that modern architecture is engineering, and on the other an equally valiant band stoutly affirms that engineering is but a help to the more artistic art. It would have been well could an extended body of both classes have listened to the discussion on the status of the engineering profession which was one of the most interesting and important topics treated at the recent meeting of the American Society of Mechanical Engineers in New York. Into the general merit and scope of this discussion it is needless for the Department of Architecture to enter, but it may at least claim the privilege of directing attention to the remarks of one of the commentators on the chief paper in the discussion, which related especially to the architectural aspect of the question. The writer referred to, Mr. George Hill, is manager of one of the largest architectural offices in New York, and his extended experience well qualified him to speak from the architectural standpoint. Especially interesting was his testimony that leading architects treat the man who does the practical part of their work in a thoroughly satisfactory way, giving him all the credit to which he is entitled and ranking him as equal in importance with the artistic and business men, who, with him, are the necessary three heads in any well-managed architect's office. Coming from a thoroughly competent judge, and based on an extended personal experience, this opinion is worthy of the widest attention, and should materially help in stifling opposite opinions which ofttimes are simply opinions, pure and simple, without either facts or experience to back them up. One other phase of Mr. Hill's remarks also calls for comment—the suggestion of employing expert advice when necessary. This is a subject in which architects frequently fail to follow the best method. An engineer is by no means an architect, but engineering enters so thoroughly into modern architectural practice, new and difficult conditions are so frequently coming up, and engineering is becoming so widely specialized, that it is almost impossible to obtain the best results without resource to expert assistance. Specialism is the watchword of the day, and if architecture is to keep abreast of modern progress, it must adopt methods similar to those which have given the greatest successes in other, though perhaps not allied branches.

THE Department of Architecture is extremely glad to direct attention to the communication from Mr. Gray, anent the sanitation of Chautauqua, which appears in "Comment and Criticism" this month. Surely the criticisms on the abominations of that village that have appeared in these pages have not been in vain if they develop even a single merit among so much badness. More important than the bringing out of the good qualities of the public closets—and it will be noted that Mr. Gray makes no defense of the private closets and other foul places whose odors poison the pure air of Chautauqua county—is the statement that a system of sewage is now in process of construction there which, it is nothing but the truth to say, will, more than anything else, make the place fit and decent to live in. But the trustees of the Chautauqua Association should find little cause for self-gratification in the fact that no pestilence or serious illness has visited their village. It is said to be a remarkable fact, that notwithstanding the large quantity of clothing habitually made in tenement houses in close contact with infectious diseases, few, if any, cases of contagion can be traced to such articles. It certainly is one of the miracles of Providence that widely-spread evils do not follow from such violations of the laws of health. Is it not more comforting, in a case like this, or like Chautauqua, to assume a standpoint similar to that taken by Mr. Moody in the late accident to the steamship *Spree*—that

prayer has done what man himself could not do? There is a tower of strength in the thought that a special Providence watches over tenement clothing and lack of sewage. If this be really so, it is well that Providence is not to be further taxed, in the latter instance, by looking after fundamental matters which wise men would have seen to in the beginning. Chautauqua will be fortunate, indeed, if the stench of its earlier years does not cling to it as an unholy odor for all time.

THE papers on English Cathedrals which Mrs. Van Rensselaer has been contributing to *The Century* for some time past have been collected into a volume.* In this new form they challenge comparison with similar works, and justly claim an importance they could not have while viewed simply as contributions to a popular magazine. The book does not profess to treat the English Cathedrals as a whole, but twelve typical examples, well chosen and thoroughly representative, have been selected. It is neither a scientific nor a scholarly treatise, but a "popular" account of the churches reviewed, abounding with the shortcomings of architectural books written for the "popular" reader. Just why it is considered necessary for architectural writers to descend to a low imaginary platform in discussing their topic for general readers is hard to understand. The rational method would certainly be to bring the readers up to the level of sound architectural discussion, rather than for a writer to burden his work with poetic description of scenery and events, or well-turned panegyrics upon everything under the sun, which Mrs. Van Rensselaer unquestionably does in this volume. And it is the more to be regretted since she has shown herself capable of better things, and the subject itself required more consistent treatment. The book is not intended for architects and specialists, as the author very frankly states in her preface, but it seems a waste of time and money to have produced so costly a volume as this—costly in the amount of money spent in its production—and not to have achieved worthier and more scientific results. The pictures of Mr. Pennell, which are a great feature of the work,—perhaps the feature which will most cordially appeal to the "popular" mind,—are really a very serious drawback. Beautiful as many of them are, they are too "sketchy"—too artistic, if that be the word—to be of real value. There are too many bits of scenery, of artistic corners, of attractive trees and similar things which caught the artist's fancy and drew his attention from the sober subjects before him. All these things, while well enough in their way, are completely out of place in an important work on architecture. The reader, even of the "popular" stamp, wants general views; he wishes to see the cathedral as it is, not distant snatches of towers at evening, or towns with all but invisible towers in the far-off perspective. Thus it happens that the most satisfactorily illustrated cathedral is that of St. Paul's, London, in which the artist seems to have tried, and certainly more successfully than in the Gothic churches, to represent the church as a whole.

The book is not an architectural handbook, or an architectural history, or even a collection of architectural essays. It is a readable, often brilliant, generally well-written, sentimental account of the sentimental aspects of twelve typical English cathedrals. It is a pity that it is such, for the sentimental side of these buildings has been so frequently written about by less competent writers that there surely was room for a good account of them from an architectural point of view. Fortunately Mrs. Van Rensselaer's sentiment does not run away with her to the extent of blinding her eyes to the relative merits of French and English cathedrals. Like every architectural student, she recognizes the great superiority of the French cathedrals over the English, and she takes ample occasion, not only in her introductory chapters, but throughout the entire work, to insist on this point, so little understood by American and English readers, and so seldom comprehended by them. Whatever exception may be taken to her method of treatment,—and it is well

* *English Cathedrals.* By Mrs. Schuyler Van Rensselaer. With Illustrations by Joseph Pennell. New York: The Century Co. 1892.

to remember, in criticising this point, that the book is only the reproduction of articles from a "popular" magazine,—her architectural conceptions are clearly right. As an offset to this, many of her historical statements are utterly wrong. The book is one that will create a wide interest in the English cathedrals, without contributing to a knowledge of their real characteristics, and it is unfortunately one which will command attention and obtain respect among a large class to which it is not entitled, and for which the authoress herself would make no claim. As a general introduction to the sentimental aspects of English cathedrals it will have a wide circle of readers, but it may seriously be questioned if it will stimulate healthy inquiry into the very topic it pretends to uphold.

NOW that the World's Columbian Exhibition buildings have been dedicated, and every critic, as well as every writer who can tell a building from a sand-heap, is rushing into print with his opinions, it is being well recognized that by far the worst of the large buildings are those not erected under the immediate direction of the Bureau of Construction, and its able chief, Mr. Burnham, but which were left to the tender mercies of officialism,—the United States Government Building and that built by the State of Illinois. A steady wail of lamentation has gone up over the shortcomings of these buildings, but most unjustly. As a matter of fact nothing could be more satisfactory than their dreadfulness, and the worse they are, the more they obtrude their lack of proportion and their foreignness to the whole conception of the Fair buildings, the better it is for art, and the more thankful the Chief of Construction and his associates should be for them. Doubtless they are not, but in that case we have simply another illustration of the inability of some men to appreciate their blessings. And the merits of the bad points of these structures lie simply in this,—that they are the most complete and effective argument for the designing of the Fair that could have been devised, more convincing and more powerful than even the wonderful beauty of the main structures themselves. There are, unfortunately, in this broad land of ours, many people who do not know a good building when they see one; if this statement is not believed, how, pray, are the atrocious structures constantly going up in the most cultured communities and admired in them to be explained? It is to be feared, further, that there are many who will look upon the art and adornment of the Chicago buildings as a waste that might better have been saved. To both of these the Government and the Illinois buildings will make the best possible answer. Here are two buildings, not erected under the immediate supervision of the Fair, designed in the atmosphere of officialism, by the most approved machine methods, and seeming more ugly than they really are, more out of place, more distorted, more abominable, by reason of their juxtaposition to the true architectural beauties produced by the Bureau of Construction, by the application of sound artistic knowledge, feeling, and appreciation of the beautiful. It is the story of beauty and the beast over again, if the comparison be a proper one. Side by side each system shines in undimmed luster, and the most casual visitor will be able to see and feel the force of art as opposed to ugliness.

IN a series of papers on "Scenic Art," recently printed in the *Magazine of Art*, Professor Herkomer presents an enthusiastic and elaborate appeal for improvements in this important field, and makes a number of interesting and valuable suggestions. Among other things he argues for a contracting proscenium, as having many advantages over the present usual arrangement of piecing out the proscenium by means of upper curtains. "I take it," he remarks, "that the proscenium should be to the stage-picture what the frame is to the easel-picture. It should separate the picture from the surroundings. But the stage-picture, just as the painted picture, should in that case reach the frame. How funny it would be," he continues, "to send a picture to the Academy in a frame that was a foot too high for the picture,

having the vacant space modestly covered with a bit of 'Liberty silk.'" And true enough it would; yet how many of our theaters are regularly built with the old-fashioned proscenium, in which every scene is pieced out with curtains or similarly arranged canvases? There is a good deal of the sheep in the architect when he comes to build a theater which has obtained a general and usual form. Doubtless this is the reason why the old-fashioned proscenium continues to be popular. Professor Herkomer's suggestion may not be suited to every theater stage, but his point is well taken. He does more than make a criticism, however, and furnishes drawings and plans for just such a proscenium as he describes. A left-handed and right-handed screw supplies the motive power for the sides of the proscenium, and the upper part is arranged for a counter-weight action, and ought, he contends, to be worked by one man. The frame completed, the Professor takes up the question of scenery, and his plans for realistic scene-painting are elaborate enough to carry dismay to the theater-manager, but to give undreamed-of delights to the spectator. There can be little question but that there is room for great progress in the preparation of stage scenery. Mr. Irving may well claim the credit of having shown the American public what may be accomplished by careful and scholarly work. Our grand-opera companies may likewise have the credit of showing the public what dreadful results may be accomplished by the neglect of the simplest contrivances. In this, as in most other artistic questions, the American public needs more education than it has yet received. The lime-light and a few colored glasses will doubtless do much, and a carefully-modeled elephant that will walk and move its ears, and, greatest wonder of all, drink a huge schooner of beer, will delight unnumbered crowds. But neither of these things represents the true art our culture should insist on upon the stage.

THE death of Professor Eugene Létang, of the Department of Architecture of the Massachusetts Institute of Technology, removes a man who, perhaps more than any one other single individual, has influenced American architecture, has set the thought of American architects moving in scholarly and artistic directions, has infused new life into our art, and, in a very large sense, personally raised it to its present position. There have been architects who, by personal peculiarities, by the affectation of uncouth forms, or by a marvelous pecuniary success, have introduced new fashions, helped to maintain new vogues in the building art; but, though their work may have long survived them, though their influences may be seen in many a building and in many a city, the results of their labors are neither as abiding nor as useful as those which came to an end in the death of Professor Létang. Actively associated with the Institute for twenty years, he dominated its architectural teaching in an unobtrusive but thoroughly effective and efficient manner. Trained in the Ecole des Beaux-Arts, he brought to this country the fine traditions of that classic establishment, applying them as thoroughly and as effectively as American conditions would permit. And it is easy to trace to this source, even to his own personality, the architectural work of this country in which the highest hopes for the future naturally center. Without founding a school in the sense of impressing a single style upon his pupils,—unless, in truth, the Renaissance in which he naturally worked and lived, and in which he was trained, be taken as such,—he led by method and by thought. A less great man, or one less broad-minded, might readily have made his own peculiarities the models for his pupils. Such was not the character of Professor Létang, and to his ceaseless love for his art as art, his thorough mastery of the technique of his subject, and his deep sympathy with his pupils and interest in their work is due, not alone the success he achieved as a teacher, but much of the best qualities in current American architecture. He died while the fruits of his labors were still undeveloped, but his finest monument is already erected in the work of his pupils.

MINING AND METALLURGY.

Conducted by Albert Williams, Jr.

THAT able exponent of the coal-mining industry, the *Colliery Engineer*, strongly urges the organization of a national commission on accidents in mines, and cites the examples set by Great Britain, France, Belgium, Prussia, and Austria as precedents. The commissions in each of these countries have now completed the work assigned to them, and their voluminous reports, rendered after investigations extending over a long series of years, are now in evidence. In each of these commissions the membership comprised men of high professional standing, and the work in part was in the nature of original research and experimentation. It would be absurd to assume that good has not been done in this way; that the men composing the British commission, for instance, after seven years of patient hearing of testimony and of study of the conditions causing mine accidents and the safeguards against such accidents should not have produced something of practical value in the shape of suggestions for the improvement of the mining laws. That the outcome has, at least in one instance, had a good effect is shown by the new mines-regulation act of Great Britain, which is conceded to be an important advance upon former legislation in that country. The same is true of the work of the commissions formed by the Governments of the continent of Europe. There is no finality in studies of this kind and the recommendations of officials, or in the accumulation of knowledge apart from officialism. All this being well understood in the profession, it is not strange that the reports of the different government commissions are appreciated for what they are worth, and that the common opinion is that they are highly creditable.

Now the very fact that an immense mass of recorded occurrences, experiments, expert opinions, theories, and practical suggestions has been accumulated and brought into available form may be taken as a sound reason why our government, instead of following in the footsteps of other governments, should *not* repeat this work and rake over ground already so thoroughly exploited. The present seems rather a time to pause and take bearings, to make use of the information now at hand, but not yet applied. The technical details of coal-mining, and also to a large extent the natural conditions in the mines, do not differ so widely in one country from another that what is learned in one cannot be applied in another.

Here, it may be suggested, is an excellent opportunity for some authority—and none can be better equipped for the task than the *Colliery Engineer* itself, with its competent corps of contributors—to undertake the systematizing of all the material now under our noses, with a view to making practical sense out of it, and to establishing a standard to be referred to in the management of collieries and for the guidance of law-makers. Let such a compendium be prepared by individual effort, by the engineering societies, or better yet by such a journal as the *Colliery Engineer*, and we fancy it will be accepted as quite as authoritative as any report emanating from a government commission. It is an opportunity for useful work in the profession and by the profession—where it properly belongs. But this would not satisfy the *Colliery Engineer*. It insists that

> The United States Government should also establish . . . a commission and equip it with means and facilities [that is, a big appropriation] to carry on similar [parallel] investigations and make a similar [duplicate] report,

And, by implication, in describing the foreign reports, to enter upon a

> Thorough research into the causes of accidents, so as to enable the formation of mine laws that would be as effective as possible in

their prevention ; . . . to make such investigations as would enable them to make positive and comprehensive reports on the various causes of accidents, and from these investigations and experiments formulate reports in the nature of suggestions that would be included in the various mine laws.

Surely a praiseworthy object. The main and decisive objection to the method advocated for accomplishing it is that it won't work ; that it would materialize—if past experience is any criterion—in the establishment of another national junketing committee, with the same delays, with the same figureheads, with the usual final long-winded reports written by subordinates and signed by high officials, and with an utter absence of such authority as is attached to official dicta in more centralized countries. In short, the means proposed is not only superfluous, but it doesn't apply to actual conditions, assuming the work to be well done.

Here are seventeen coal-mining States having laws designed for the protection of the miner's life. These laws are not uniform, but they are all well-intended ; and some of the variations are caused by actual and natural peculiarities of the ground. Where amendment, addition, or annulment is desirable, the law-makers have a fund of information, more or less directly applicable, at hand. They can examine the reports, foreign and domestic, already printed, and can form their new laws accordingly. That is, pending the issue of the suggested compendium by the *Colliery Engineer*.

Coal-mining accidents of course only present one phase of the larger question of accidents in general. But the same reasoning as to the advisability of governmental interposition in local affairs applies.

RELATIVELY few mines in this country use direct water-power for operating their pumping and hoisting machinery, though water-power is extensively used in running the gold and silver mills and concentration-plants. The mills can be placed in such positions as to utilize the head to best advantage, while the shaft-houses have to be where the mines are,—that is, usually at a considerable elevation above the neighboring streams. For this reason electric transmission of power is being so largely adopted for mines situated at great altitudes, (especially where fuel would have to be hauled up grade and even water for boilers is scarce), the power being sent up from stations at the lower lying sources. The introduction of this system has also enabled the mills in some cases to be placed at convenient sites just below the mine shafts or tunnels (provided sufficient water for other purposes than power is there available). But in California, particularly in Nevada and Placer counties, there are a number of gold-quartz mines which are favorably situated for the employment of water-power directly or by short wire-rope transmission, the mine openings themselves being at comparatively low altitudes, while the canal and flume systems originally constructed to supply the hydraulic mines are carried at so high elevations as to furnish water under a pressure of several hundred feet to the shaft-houses. Since the cessation of hydraulic mining the ditches and flumes of the water companies have been extended for the purpose of supplying the quartz mines. The water is sometimes used more than once, by mines at different altitudes, and finally it is distributed for irrigation. In Nevada county the rate charged for water used as power at the quartz mines is 18 cents per 24-hour miner's inch, which makes the cost per horse-power per day from 11 to 24 cents, according to the pressure at different mines, say from about 600 feet down to 300 feet fall or less. In that region the only dividend-paying mine at present using steam-power does so at a cost of 46 cents per horse-power of engines per day ; and the general economy of the water-power is shown by the statement that steam would cost, for most of these mines, from 50 to 75 cents per daily horse-power. But as a general rule the utilization of water-power for mining will be by electric transmission rather than by direct application, for there are not many mining districts so situated as to be able to adopt the California method ; and even where it might be possible to use water directly there are obvious advantages in the electric-trans-

mission plan, on the score of greater convenience, the availability of electricity for underground work and for lighting, and the gain in pressure by placing the power stations at the best points, perhaps far below the mines. In California, too, if hydraulic mining had not in the first place necessitated the construction of the great and costly high-line water systems, with their immense reservoirs, canals, flumes, and pipes, it is doubtful if the demand for the quartz mines alone would have justified the first cost. To take power from water flowing at almost natural grades is a much simpler matter, and this the progress in electrical engineering has enabled the miners to do.

"LE GRISON" is the title of a treatise on fire-damp by M. H. LeChatelier, professor at the Ecole des Mines and member of the French fire-damp commission. In it the present state of knowledge of the nature and origin of fire-damp is reviewed critically and with the admirable clearness so characteristic of French technical literature. The author's conclusions as to a number of knotty and much discussed points are very definite and positive; but while they may not present a final solution of these difficulties, they can be accepted as representing an advanced stage of opinion. In discussing the nature of fire-damp M. LeChatelier criticises the methods of collecting samples, analytical methods, and the computation of results. He limits the sources from which samples should be taken to two,—natural blowers and bore holes in the coal. This limitation excludes all analyses based on samples obtained by heating the coal to 100 C. in a vacuum, at which point some coals begin to decompose, instead of merely giving off gas imprisoned in the pores. The eudiometric method, with the determination of all the combustible gases other than the protocarbide (marsh-gas) by difference, gives, he thinks, unreliable results, and he maintains that it is impossible to determine quantities of foreign gases less than 1 per cent., while it is only possible to be certain as to their presence where calculation shows a content of at least 6 per cent. This is a matter of great importance in regard to the more combustible and sensitive gases and vapors, as ethylene, free hydrogen, etc., assumed by some to be normally present. In short, he concludes that hitherto protocarbide of hydrogen (marsh-gas) is the only combustible gas the normal presence of which in fire-damp has been definitely ascertained. If others are to be found in the future, he thinks it reasonable to suppose that they will be chiefly the vapors of heavy carbides, liquid or solid, the indeterminable traces of which would suffice for the odor given out by certain coal seams. This, it will be noticed, is practically the same as Davy's conclusion eighty years ago that fire-damp is a protocarbide of hydrogen mixed with small quantities of inert gases (nitrogen and carbonic acid), and differs radically from opinions subsequently held, without absolute proof as to the presence of free hydrogen and carbides of the ethylene class.

As to the origin of fire-damp, the author holds that its formation was certainly contemporaneous with that of the coal, and explains that the existence of a thick covering of heavy and impermeable matter is indispensable to account for the retention of the large quantities of fire-damp now found in the coal and in adjacent porous strata. Here is a contradiction of the theory of continuous and present decomposition of coal; and the opinion has also a bearing upon theories of the origin of natural gas. In regard to the physical conditions determining the accumulation and pressure of fire-damp, the author follows the conclusions of Mr. Lindsay Wood and M. Mallard, and says that the great pressure of the gas can only be counterbalanced by the weight of overlying rocks, and that this is the reason why seams very much charged with fire-damp are usually met at great depth. This conforms with the general observation that where a seam crops out at the surface it contains less and less fire-damp in proportion to the height, and accounts for the steady emission of gas from the working faces of the coal as the restraining pressure is relieved by the advance of the mining. It is not to be expected that M. LeChatelier's

memoir will be accepted as authoritative in all respects. There is room for differences of opinion on many points. But it marks a distinct stage in the literature of the subject, and will command attention because of the directness and precision of treatment.

ALTHOUGH mining has been carried on regularly in Alaska for twelve years or more, it cannot be said that the mineral resources of its vast territory have yet more than been surmised. Work has been confined almost exclusively to the coast region, with prospecting for gold placers along some of the principal rivers. Besides the few gold-quartz mines and more numerous placers, and some silver mines which have not proved very successful thus far, there are deposits of coal, iron, lead, and antimony which are undeveloped, and their extent and value are not yet definitely known. Captain A. M. Brown, who has made several tours inland during the last two or three years, states that for some years miners have been working the bars of the Yukon and other rivers to the south of it for gold, but very little prospecting has been done in the interior. The bars and banks of many streams contain gold which must have come from disintegrated quartz veins of the interior mountains, where some day doubtless the original ledges will be found. A member of one exploring party stated that he had prospected the banks and bars of Putnam river for 300 miles from its mouth, and could not remember that he had found a spot of ground in the entire distance that did not contain gold. Captain Brown avers that there is hardly a stream flowing into the Behring sea or the Arctic ocean between the head of Norton sound and the head of Kotzebue sound that does not carry gold. Quartz mining, according to his account, can be carried on the year round as advantageously, if not quite as comfortably, there as in many of our active mining districts. In the latitudes above Galovine bay mining must be limited to about two months of the year.

Alaska, however extensive and diversified its mineral wealth may be, has not proved to be a very profitable field for the prospector, nor for miners and companies working on the small scale. As to the placers, while they are numerous enough, none seem to resemble the shallow but rich placers which in the "early days" of California, Idaho, Montana, Colorado, and the Australian colonies yielded so handsomely, at least for a short time, under the crude methods employed by the first discoverers. The quartz veins and other deposits of ore in place appear to have a corresponding peculiarity, or in other words are usually characterized by largeness of size and lowness of grade. Of course there are no known geological reasons why this should be so; and the very limited amount of prospecting done thus far does not warrant a sweeping assertion that such will be found to be an invariable or even a general characteristic. But present imperfect knowledge still, as heretofore, points to Alaska as a more inviting field for the operations of companies able to meet the large preliminary outlays inevitable in attacking what are called "low-grade propositions" than it is for men of small means.

RECENT articles in the *Engineering and Mining Journal* on the improvement of coke present the salient points of the subject in a very clear and practical light. Of course in this, as in all similar cases, the vital question to the producer is whether the cost of improving the quality of the coke will correspondingly increase the selling price or its market range; if not, there will be no object in attempting the improvement. Careful mining of the coal has much to do with the final outcome, but this is a separate matter. The main points discussed in the *Journal* are the crushing and the washing of the raw coal, and as to the former it is stated that:

> Of the dry-methods for improving coke the only one that seems to be worthy of attention is the pulverization of the coal. A company operating more than 450 beehive ovens informs us that since it began to pulverize the coal to the fineness of meal there has been a marked improvement of the coke, not so much in chemical composition as in structure,—a very important

item. Then, again, it has been observed that the coking quality of a coal is improved by fine crushing. Some coals that coke badly when coked as "run of mine" or even as slack are greatly improved by fine crushing. This would be the case particularly with slaty or dirty coal, as the comminution of the particles would allow the bituminous or coke causing ingredients to sinter the mass more firmly together. It must be borne in mind, however, that crushing does not remove any impurities from coal. All that is done is to better the structure of the coke. This is very important, but does not affect the fundamental question of purer fuel.

The *Journal* explains how the physical betterment of the coke caused by preliminary crushing of the coal increases its value, and says that such improvement is not to be despised, especially in coke destined to much transportation or breaking in bulk. This leads to the consideration of the gain in strength without other important change caused by "overheating,"—that is, burning the coke beyond the point at which combustible matter is given off, which for most coals is 48 hours in the beehive oven. In one extreme case quoted the crushing resistance of 48-hour coke was 700 pounds, and the 72-hour coke from the same coal withstood 1100 pounds crushing strain per square inch. In regard to this increase of strength, however, as the *Journal* points out, an improvement that is to bring the coke above a resistance of 500 pounds need not be considered, though the time element is important with weaker material. Finally, as to washing:

> Coke from washed coal will cost more than ordinary coke, and if it commands no more in the market there is no reason why the works should make it. It is generally accepted that with proper care in the mining the standard Connellsville and Flat Top coals do not need to be washed for the production of high-grade coke. . . . But with the more southerly coals the case is different,—so different, indeed, that it is probable that every ton of coke now made of unwashed coal in Tennessee, Georgia, and Alabama is much below the quality that could be obtained from washed coal.

Precisely what percentage of the removable dirt (ash) and sulphur can be eliminated by washing the coal must be determined for each individual case. There is no general rule, and experimental results vary widely. Unquestionably there is need of close study and great care in making coke for iron-smelting. That which is destined for less exacting uses, as lead-smelting for example, does not have to come up to the same standard. Indeed, throughout a wide area in the West the great problem is to get a coal that will coke at all; so that inferior qualities are acceptable.

A NEW appliance has lately been successfully introduced for the treatment of auriferous cement gravels. It is a machine which breaks up the cement and frees the gold, cleaning the boulders and cobbles, but not crushing them. This appears to be a marked improvement upon the usual practise of crushing the whole of the material by stamps, since in most cases the coarser pebbles, cobbles, and boulders are practically barren of gold, and it is only a disintegration of the cement that is needed. The cement-stamp mills, it is true, are designed with reference to this peculiarity of the material, but they cannot avoid doing a great deal of unnecessary crushing, with a corresponding waste of power and loss in capacity. The pulverized material prepared by the machine here referred to is washed and the gold is mainly saved by gravity without the use of quicksilver.

IN describing the newly-opened zinc-mining area in northern Arkansas, a writer in the *Manufacturers' Record* says that two years ago the region was not prospected, while to-day there are more than 4000 mining-claims staked out. Only a year ago there was no regular zinc-mining there, but now several mines are reported as working successfully. The construction of a railroad through the heart of the mineral belt is being actively pushed, and altogether, according to the writer quoted, the outlook is very encouraging. Arkansas has been rather backward in developing her mineral resources, among which are also coal, iron, manganese, copper, lead, antimony, white and colored marbles, onyx, lithographic stone, novaculite, limestones, and sandstones.

INDUSTRIAL CHEMISTRY.

Conducted by Dr. R. A. Witthaus.

THE spelling reform is progressing among chemists. Indeed its ultimate universal adoption in this country, if not in England, seems to be assured. Professor Thomas H. Norton, one of the committee of the American Association for the Advancement of Science having this matter in charge, has an explanatory paper in the November number of *Science*. The United States Bureau of Education has recently issued an edition of the rules, printed upon a single sheet of Bristol-board for distribution among schools and colleges. The most important changes are two:

1. The dropping of the terminal *e* in all names terminating in *ine* and *ide*, except those of doubly saturated hydrocarbons, and pronouncing the vowel of the terminal syllable short (*e. g.*, fluorin in place of fluorine; iodid in place of iodide).

2. The substitution of the simple *f* for the diagraph *ph* in sulphur and its derivatives, sulphate, sulphite, sulphocyanide, etc. The new rules will be followed in the writing of this Department.

A REVIEW of the coal-tar industry in Great Britain for the year 1891, published recently, shows a marked falling off in business and in prices. The review ascribes this largely to the competition of the coke-ovens on the one hand and to the increased use of electric light on the other, and predicts a future for the tar trade rather darker than those concerned might wish. At the beginning of 1891 the trade is described as having been fairly brisk, but both trade and prices declined rapidly, the latter in some cases as much as 50 per cent. Fifty- and ninety-per cent. benzene were quoted in January at 3s. 6d. and 4s. 9d. per gallon (London), and in December at 1s. 9d. and 2s. 2d, respectively. Phenol has suffered from Koch's publications, which have rather placed it in disfavor as a disinfectant, while creolin and lysol have likewise proved a disappointment to physicians on account of the cloudy, opaque nature of the preparations, and also because of the loosely combined alkali contained. There are indications that in the near future gas-manufacturers may be obliged to retain their benzene in the gas that the illuminating power may prove satisfactory to the public; and should this be so, the depreciation in price, owing to the increased production of benzene, on the part of the coke-ovens, may be avoided. Certain advances are being made, however, which are not unlikely to materially increase the demand for tar-products. Among these are mentioned the effort to use cresol in a perfectly soluble form; the use of benzene to assist the solution of resins, such as copal; the employment of highly nitrated tar-hydrocarbons as explosives; the employment of paramidophenol as a developer in photography; and of anthranilic acid in the manufacture of artificial indigo. Considerable advance has also been made on the more scientific side of the coal-tar industry by the investigations of Liebermann, Baur, Etard and Lambert, Fabini, Schwarz, and others. Fabini claims to have determined the nature of the coloring matter in phenol,—the red coloration formed when exposed to light and air,—and has assigned to it the name phenerythrene, but he has not actually isolated such a body nor has he proved that his artificial color is identical with the natural one.

OF some interest in connection with the above review is a paper read by Mr. T. Bower before the meeting of the North of England Gas Managers' Association on "Tar as Fuel." In this paper Mr. Bower refers back to a time six years ago when tar, being almost unsalable owing to the

extremely low prices then ruling, began first to be consumed by many in place of coke in the retort furnaces. With this new use the price of tar steadily increased until it reached a figure that prohibited its further economic application as a fuel. From a study of reports and statistics Mr. Bower concludes that, whereas in many cases the exclusive substitution of tar for coke would not be economical, in other cases (of perhaps equal number) the substitution could advantageously be made. This is thus left for each manager to determine for himself, he alone being able to judge intelligently for his own locality and condition. For the average quantity of tar used per ton of coal carbonized, Mr. Bower gives as a result of his own experience thirty gallons; or in other words seven and one half gallons of tar are equal to one hundred weight of coke. Although, as stated, for some years the price of tar has been rather prohibitive of its use as a coke substitute, at the present time there is occurring a trade depression which, lowering the price of residual products, again brings the subject of tar fuel before the gas managers.

FOLLOWING closely upon the production of tar in coking-ovens comes the more recent recovery of ammonia from the blast furnace gases; and thus another of the gas-manufacturers' residual products is affected more or less. It is stated that the sulfate of ammonia has fallen slightly since the introduction of this new source of supply, and it is reasonable to assume that this fall is in consequence of the same. There has recently been published a description of the new plants of the Carnboe works, and while they are necessarily extensive and somewhat complicated the experience so far seems to promise profit. The statistics quoted are of interest. In the manufacture of illuminating-gas in Great Britain at the present day, 7,000,000 tons of coal are used per annum, and 100,000 tons of sulfate of ammonia produced, representing a value of £1,000,000. The coal used in connection with the iron works amounts to 15,000,000 tons, and until very recently the hydrocarbons and ammonia contained have gone to waste. Scotland seems to be in the lead in the development of this new industrial economy, while the rest of us are looking on with interest and awaiting results. The results, however, seem already assured, and no doubt the near future will see extensive and rapid advance over the present wasteful methods universally in vogue.

ANOTHER bye-product of iron-manufacture—basic slag—has rapidly come into the market as a fertilizer, but the indications are that with a much increased output it will not be an important factor in the phosphate market for some years to come. It is, however, an additional source of revenue to the ironworker, and in a local market of easy access it will no doubt prove valuable. To one familiar with the slag-heaps that mar every iron country and are such a source of general annoyance and waste, the use of even a small portion in a manner profitable to man will undoubtedly give much gratification. Dr. Von Reis in the *Zeitschrift für Angewandte Chemie* has published the results of some useful and interesting investigations regarding the wide difference in hardness often noticed in basic slags. The slag is either cooled in the truck, where the cooling takes place slowly, or it is poured and cooled rapidly, forming slabs oftentimes of great hardness. This Dr. Von Reis, by comparative analysis, finds to be due to differences in chemical composition. The hard slags are found to contain a higher percentage of ferrous oxid, FeO, and less ferric oxid, Fe_2O_3, than the softer and more friable slags. The hypothesis offered, and which seems borne out by the facts, is that in the slag there exists calcium ferrate and manganate, that these compounds are decomposed in the cooling, and that the extent of the decomposition depends upon the rate of cooling. In the decomposition ferric and manganic oxids are set free and disseminated throughout the mass. In a rapid cooling, however, this dissemination is impeded to a certain extent, the result being a lower percentage of ferric oxid, and as seems to be a consequence the superior hardness noticed. The cost of melting

being such a large item in the preparation of the slag for the market, it would seem desirable that the producer look more carefully to the manner of cooling than is customary.

A NEW impetus has been given to the old-world production of phosphates by the development of the deposits in Tunis and Algeria, these promising at an early date to rival those of America. The beds, as described by M. Thomas in the *Bulletin de la Societé Geologique de France*, resemble those of Cipley in Belgium and of Taplow in England. According to the *Chemical Trade Journal*, London, the phosphate occurs in well-defined strata overlaid and underlaid by a more or less crystalline limestone, all tilted at an acute angle so that the out-crop is distinct and easily worked. This out-crop has been exhaustively examined in part by competent engineers, while still other deposits have been discovered and not yet examined. The beds carrying the phosphate chalk have a thickness of 30-50 meters (98 to 164 feet), the richest having a mean width of 10 meters (33 feet), and averaging 50 per cent. of lime phosphate, which can be readily increased to 60 per cent. by washing. The French engineers who have conducted the survey estimate 10,000,000 tons of 60 per cent. phosphate in sight, all of which can be extracted without machinery. "Pebble" has also been found in many respects identical with that of Florida, consisting of a phosphatic chalk, covered, however, with a dark crust of resinous phosphate. The phosphate carries less than 1 per cent. of iron and alumina aud very little silica. There is about 8 per cent. of organic matter.

Concessions for mining have already been secured from the Government by a French syndicate, and a railroad is projected to reach the deposits, which are on the "haut Plateau" of Tunis, 200 kilometers (124 1/4 English miles) from a seaport. Labor is cheap and water is plentiful, so that there are indications of an active development in the near future and a possible strong competition for our own Florida phosphate. This will, however, not be entirely disastrous, but on the contrary will rather push our American companies into more approved methods of working and development, which will be of distinct advantage to all concerned.

WE extract the following from a paper read by Mr. C. R. Collins before the twentieth annual meeting of the American Gas-Light Association upon the "Selection of Anthracites for Water Gas." While advance in mechanical details of generator design has almost reached a limit, the economical combustion of coal is far from being perfected, all grades being subjected to like conditions of blast and gas-making, whereas these conditions should vary in each case under consideration. The necessity of selling the product of the generator at decreasing price will lead to refinement of methods and thereby an annual saving to every water gas manufacturer. In undertakings involving the use of great quantities of materials it seems inexpedient to depend upon the old process of trial and error for the economical utilization when the crucible and pipette reveal promptly and definitely facts that we usually grope for in the dark. Many coals have been carefully analyzed and practically tested, the results of which tests are to appear at a later date. The coals in use are mainly from the Pennsylvania fields, the Lehigh basin furnishing the hardest, clearest, and purest anthracite, characterized by dense structure and little volatile matter. The different grades of coal are recognized by the mining engineers as hard, dry anthracite or as semi-anthracite with a classification based on their fuel ratios, *i. e.*, the proportion of fixed carbon to volatile hydro-carbons $\frac{C}{V.H.C.}$

In the selection of the coal the purchaser is to be guided by the following general considerations :

The hard, dry anthracites are to be preferred, being clear burning and not breaking up under a forced blast. The fire is thus kept open throughout, each lump burning free and without splintering. This grade also contains the greatest amount of fixed carbon and the least inert matter.

In the selection of coal the size is an all-important factor and is somewhat governed by the size of the generator. In every generator the central part of the fire is comparatively inactive, this being the result of loose packing against the side-walls, the blast thus taking the passage of least resistance. Egg coal (passing a 2½- to a 3¾- inch mesh) renders about 30 per cent. of the construction of the fire partially inactive, while broken coal (passing a 4-inch mesh) affects about 15 per cent. of the fuel bed. Steamboat and lump coal give a practically free fire. There are other considerations, however, and experience shows that lump coal is not an efficient size. It presents a surface of but 6 square feet for each cubic foot of generator space, and on account of its size is difficult to handle. Steamboat presents 16.6 per cent. more surface than the lump, and for generators exceeding 8 feet in diameter it may have distinctive advantages, but like lump it can scarcely be handled by automatic conveyors. Broken coal, if of standard size, commends itself as offering all of the conditions that go towards the attainment of economical results.

The specific gravity of a coal seems to increase in a fairly constant ratio with the amount of inert matter present. The best anthracites vary either way from about 1.5.

The clinker and ash should be examined, as here can be best seen the presence of slate. With too high a heat the clinker is spongy and open, carrying unconsumed coal. A coal yielding a hard, dense, white ash produces the least waste.

A GREAT advance over old methods has recently been made in the English alkali manufacture, by which not only is all waste and nuisance avoided, but also that trade which has gradually been leaving England for the Continent is brought back and one at least of the British manufacturers given an eminent supremacy over all competitors. The process, briefly, is as follows, the raw materials being salt, chalk, and coal.

There is first a destructive distillation of the coal, producing combined gases, which are stored for future use as fuel; ammonia, used in repairing the slight waste during the process; and coke which is used in burning the lime in the kilns. The second step consists in the burning of the lime, producing caustic lime (Ca O) and carbonic acid ($C O_2$). The brine is pumped from the well, treated with ammonia, and then with carbonic acid, and thus a bi-carbonate of soda is formed and crystallized out, while the ammonium chlorid remains in solution. In the old method this ammonium chlorid solution is boiled with lime and the ammonia collected while the chlorid of lime was allowed to run off,—producing no nuisance but great waste. In the new process the ammonium chlorid solution is frozen by means of an ammonia refrigerating-machine, and the ammonium chlorid is crystallized out, dried, and sublimed. In the last step it probably suffers temporary decomposition, hydrochloric acid (HCe) and ammonia (NH_3) being separated. This vapor is passed over magnesia (MgO), and water, magnesium chlorid ($Mg Cl_2$), and ammonia (NH_3) are obtained, the latter being collected. Hot air is passed over the chlorid, and magnesia and chlorin are produced; the chlorin is passed over caustic lime from the kilns and then slacked with water with the production of bleaching powder, while the magnesia (Mg O) is left ready for the decomposition of a fresh batch of ammonium chlorid. The whole process then is continuous, and nothing is lost but the coal.

WE abstract the following from a paper on "The Flash-point and Heat of Burning of Mineral Oils," read by Mr. D. R. Steuart before the Glasgow Section of the Society of Chemical Industry. In determining the safety of an oil the first point to be determined is the temperature at which a "flash" is given; in other words, the lowest temperature at which an explosion of the vapors given off occurs when a light is applied to the mixture of air and vapor. The flash thus obtained goes out immediately, while at a somewhat higher temperature the vapors are evolved sufficiently fast to keep up a constant flame, this constituting what is known as the firing point (or burning point). In obtaining the flash-point the oil was formerly placed

in an open cup, the surface exposed to the air, and a point was thus obtained above the true flashing point. This plan of operation was eventually rejected, however, because of the difficulty met with by different experimenters in arriving at like results, and at the present time the close test of Sir Frederick Abel is prescribed by Parliament. The cup containing the oil is kept covered when heating, the test being applied from time to time through two small holes, and the lowest possible temperature at which an explosion might occur is thus determined. By certain experimenters this new test gave a flash at 73° F., for an oil previously flashing, by open cup, at 100° F., and this temperature has been taken as one of safety. In deciding as to what constitutes a point of safety the highest ordinary temperature of the climate must be considered, and thus it will be seen that under many conditions oil flashing at 73° F. is as dangerous as naphtha. At least 100° should be taken as the flashing point of safety, and this is ordinarily obtained by the Scotch manufacturers, who find a ready and profitable market for the lighter products of distillation. American manufacturers, however, finding little profit in the naphtha owing to overproduction, are inclined to put as much as possible in the oils for export, and consequently much of the petroleum received in England flashes from 73° to 80°. Mr. Steuart ascribes the comparative rarity of explosions to the fact that through dire experience the people have become more intelligent than the Government, which has fixed the minimum flashing point so low; and by treating and handling the petroleum as an explosive and dangerous fluid many accidents have been avoided. There are, however, many deaths each year, particularly among the poorer classes, which would have been avoided had the flashing point been fixed at 100°. The higher-priced brands of petroleum used by the rich are more homogeneous in their mixture, with flashing points ranging from 100° to 125° F., so that under ordinary circumstances and with ordinary care they may be assumed to be perfectly safe. The Government's advisers, it seems, have been rather unfortunately selected, one of them being Mr. Boverton Redwood, who long ago as chemist for the Petroleum Association was a strong advocate of low flashing oils. Together with Sir Frederick Abel, the second governmental adviser, Mr. Redwood, published a report on lamp accidents, which is throughout a biased, one-sided argument for low flashing points; their own collected statistics, however, showing that the accidents recorded, with one exception, were caused by low flashing points and would have been avoided had the flashing points been above or at 100° F.

In face of facts by themselves recorded they agree that 73°, or even a lower point, is safer than anything higher; and that the safest oil is at its greatest safety when heated above its flashing point. In short, as Mr. Steuart remarked, their opinion is "the lower the flash the safer the oil," and consequently 73° should be taken as a maximum instead of a minimum temperature of safety. Throughout, the report of Abel and Redwood is contrary to all experimental results, is contrary to scientific theories, and, fortunately for the safety of petroleum consumers, is contrary to common sense. In this last we have at least an element of safety, for people are not easily misled by opinion so opposed to their own good judgment. In regard to the metallic lamp reservoirs, which they advocate, they say: "Moreover, the heating of oil does not necessarily increase the probability of the formation of an explosive mixture; on the contrary, any increased volatilization resulting therefrom would have the effect of increased expulsion of air from the reservoir, so that the vaporous contents would be rendered inflammable instead of explosive. A lamp intended to be used with ordinary petroleum oil, and having an unprotected burner, is in the safest condition when the proportion of vapor to air is considerably in excess of that required to produce an explosion." It seems strange that such a report can come from competent men, who are in a position to know of what they are writing. Yet such is the case, and Mr. Steuart's paper calling attention to the fact presents a very interesting state of affairs

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In the body of the index the initials of the papers quoted are given, and these can be readily identified by the alphabetical list of periodicals. Other abbreviations are: Ill=illustrated. W=words.

PERIODICALS INDEXED.

THE AMERICAN PRESS.

A .....Arena. *m.* $5 per year. Boston.
AA.....American Architect. *w.* $6. Boston.
A A A....Annals of Am. Academy of Political and Social Science. *b-m.* $6. Philadelphia.
A An.... American Analyst. *f.* $1 per year. N. Y.
A Ar.....American Artisan. *w.* $2. Chicago.
A & B....Architecture and Building. *w.* $6. N. Y.
A B M...Architect, Builder, and Manufacturer. *m.* $1.50. Kansas City, Mo.
A C J....Am. Chemical Journal. *b-m.* $4. Baltimore.
A D... ..American Druggist. *m.* $1.50. New York.
A E .....Architectural Era. *m.* $3. N. Y.
A G.....Am. Geologist. *m.* $3.50. Minneapolis.
A G L J...Am. Gas Light Journal. *w.* $3. New York.
A H.....Annals of Hygiene. *m.* $2 per year. Phila.
A J Phar.Am. Journal of Pharmacy. *m.* $3. Phila.
A J R A..American Journal of Railway Appliances. *m.* $2 per year. New York.
A M.....American Machinist. *w.* $3. New York.
A M & I W.American Manufacturer and Iron World. *w.* $4 per year. Pittsburg.
Am M....American Miller. *m.* $2. Chicago.
Am S....American Shipbuilder. *w.* $2. N. Y.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3 per year. Washington.
A R.....Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
At M.....Atlantic Monthly. *m.* $4 per year. Boston.
B B.....Brick Builder. *m.* $2.50. Boston.
B J C....Boston Journal of Commerce. *w.* $3 per year. Boston.
B P .....Bulletin of Pharmacy. *m.* $1. Detroit.
B & W...Builder and Woodworker. *m.* $1. N. Y.
C..... .Compass. *m.* $1 per year. New York.
C A.....Calif. Architect. *m.* $3. San Francisco.
Can A.. Canadian Architect. *m.* $2. Toronto.
C & B... Carpentry and Building. *m.* $1. New York.
C B T....Builder and Trader. *w.* $2. Chicago.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C E N....Canadian Electrical News. *m.* $1 per year. Toronto.
Ch.....Chautauquan. *m.* $2. Meadville, Pa.
C M.....Century Magazine. *m.* $4 per year. N. Y.
Cos..... .Cosmopolitan. *m.* $3 per year. New York.
D E.....Domestic Engineering. *m.* $1. Chicago.
D J ... ..Drainage Journal. *m.* $1. Indianapolis.
D Jour. .Druggists' Journal. *m.* $1. Chicago.
E A.....Electrical Age. *w.* $3 per year. New York.
E E N Y..Electrical Engineer. *w.* $3 per year. N. Y.
E I.....Electrical Industries. *m.* $3. Chicago.
E M.....Engineering Mechanics. *m.* $2. Phila.
E Mag ...Engineering Magazine. *m.* $3. New York.
E M J....Engineering and Mining Journal. *w.* $4 per year. New York.
E N.....Engineering News. *w.* $5 per year. N. Y.
Eng .....Engineer. *s-m.* $2 per year. New York.
E N Y....Electricity. *w.* $2.50. N. Y.
E P D....Electrical Progress and Development. $2. Boston.
E R.....Engineering Record. *w.* $5. N. Y.
E & R ...Electricity and Railroading. *m.* $1 per year. Boston.
E R N Y..Electrical Review. *w.* $3 per year. N. Y.
E W.....Electrical World. *w.* $3 per year. N. Y.
F .....Forum. *m.* $5 per year. New York.
F M.....Farm Machinery. *m.* $1. St. Louis.
F W .....Fire and Water. *w.* $3 per year. N. Y.
G & F....Garden and Forest. *w.* $4 per year. N. Y.
G G M...Goldthwaite's Geographical Magazine. *m.* $2 per year. N. Y.
G R.....Good Roads. *m.* $2 per year N. Y.
I A.....Inland Architect. *m.* $5 per year. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
Ir Age..Iron Age. *w.* $4.50. N. Y.
I R W...India Rubber World. *m.* $3 per year. N.Y.
I S F....Industry. *m.* $2 per year. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
J A... ..Journal of Architecture. *m.* $2. Phila.
J A C S..Journal of the American Chemical Society. *m.* $5 per year. N. Y.
J A E S..Journal of the Association of Engineering Societies. *m.* $3 per year. Chicago.
J F I.....Journal of the Franklin Institute. *m.* $5 per year. Philadelphia.
J M S I..Journal of the Military Service Institution. *b-m.* $4 per year. Governor's Island, N. Y. H.
J N E W.Journal of the N. E. Waterworks Association. *q.* $2. New London, Conn.
J U S A..Journal of the United States Artillery. *q.* $2.50. Fort Monroe, Va.
L E.....Locomotive Engineering. *m.* $2. N. Y.
L F M...Locomotive Firemen's Magazine. *m.* $1. Terre Haute, Ind.
L M.....Leather Manufacturer. *m.* $3. N. Y.
L Mag...Lippincott's Magazine. *m.* $3. Phila.
L P.....Louisiana Planter. *w.* $3. New Orleans.
M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
M & El...Mechanic and Electrician. *w.* $2 per year. St. Louis.
Met W...Metal Worker. *w.* $2 per year. N. Y.
M G.....Manufacturer's Gazette. *w.* $2.50. Boston.
Min .....Minerals. *m.* $1 per year. N. Y.
M I T....Mining Industry and Tradesman. *w.* $3 per year. Denver.
M N.....Mechanical News. *s-m.* $1.50. New York.
M R.....Manufacturer's Record. *w.* $4. Baltimore.
M R C...Marine Review. *w.* $2. Cleveland, O.
M S P....Mining and Scientific Press. *w.* $3 per year. San Francisco, Cal.
M S R....Mining and Scientific Review. *w.* $2 per year. Denver.
N A R...North American Review. *m.* $5. N. Y.
N B .....National Builder. *m.* $3. Chicago.
N B D. .Northwestern Builder and Decorator. *m.* $2. Minneapolis.
N C B...National Car Builder. *m.* $2. N. Y.
N M. ...Northwestern Mechanic. *m.* $1. Minneapolis.
N W.....Northwestern Architect. *m.* $3. Minneapolis.
O M.....Overland Monthly. *m.* $3 per year. San Francisco.
O P D R..Oil, Paint and Drug Reporter. *w.* $6. N.Y.
P..... ..Paving and Municipal Engineering. *m.* $1 per year. Indianapolis.
P A.....Progressive Age. *s-m.* $3. New York.
P D. ....Painting and Decorating. *m.* $1. Phila.
P E. ....Practical Electricity. *f.* $2 per year. Boston.
P E C P.Proceedings of the Engineers' Club. *q.* $2. Phila.
P Era... Pharmaceutical Era. *s-m.* $2. Detroit.
P L.....Pacific Lumberman, Contractor, and Electrician. *w.* $3. San Francisco.
P M. . .Paper Mill. *w.* $3. N. Y.
P R.....Pharmaceutical Record. *s-m.* $1.50. N. Y.
P S.....Power-Steam. *m.* $1 per year. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
P S N...Popular Science News. *m.* $1. Boston.
R A.....Railway Age. *w.* $4 per year. Chicago
R A E J..Railroad and Engineering Journal. *m.* $3 per year. New York.
R C J....Railroad Car Journal. *m.* $1 per year. N.Y.
R G.....Railroad Gazette. *w.* $4.20 per year. N. Y.
R M.....Roller Mill. *m.* $2. Buffalo, N. Y.
R M M...Railway Master Mechanic. *m.* $1. Chicago.
R P.....Registered Pharmacist. *w.* $1. Chicago.
R R.....Railway Review. *w.* $4 per year. Chicago.
R S P....Rudder, Sail and Paddle. *m.* $2. N. Y.
R T .....Rose Technic. *m.* $1. Terre Haute, Ind.
R & T...Roofer and Tinner. *m.* $1 per year. N. Y.
S..... ..Stone. *m.* $2 per year. Indianapolis, Ind.
S A.....Southern Architect. *m.* $1. Atlanta.
San.....Sanitarian. *m.* $4 per year. Brooklyn.
Sc.....Science. *w.* $3.50 per year. New York.
Sc A.....Scientific American. *w.* $3. N. Y.
Sc M....Scribner's Magazine. *m.* $3. N. Y.
S E.....Stationary Engineer. *w.* $2. Chicago.

Sea.....Seaboard. *w.* $2 per year. N. Y.
S Ec.....Social Economist. *m.* $2. New York.
S Era...Sanitary Era. *m.* $1 per year. N. Y.
S J E....Sibley Journal of Engineering. *m.* $2. Ithaca, N. Y.
S M.....Scientific Machinist. *m.* $1.50. Cleveland, O.
S M Q...School of Mines Quarterly. $2. N. Y.
So L.....Southern Lumberman. *s-m.* $2. Nashville, Tenn.
S P.....Sanitary Plumber. *s-m.* $1. N. Y.
S R G....Street Railway Gazette. *w.* $3. Chicago.
S R J....Street Railway Journal. *m.* $4. New York.
S R N. ..Street Railway News. *w.* $3. N. Y.
S R R....Street Railway Review. *m.* $1. Chicago.
S V.....Safety Valve. *m.* $1 per year. N. Y.
T. .....Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E. Transactions American Institute of Electrical Engineers. *m.* $5 per year. N. Y.
T C E....Transactions American Society of Civil Engineers. *m.* $10. N. Y.
T Q.....Technology Quarterly. $3. Boston.
W E.....Western Electrician. *w.* $3. Chicago.

THE FOREIGN PRESS.

A M S...Australian Mining Standard. *w.* 30*s.* per year, postpaid, Sydney, Australia.
C G.... ..Colliery Guardian. *w.* 27*s.* 6*d.* per year, post-paid. London.
C R.....Contemporary Review. *m.* $4.50 per year, New York. London.
C T J....Chemical Trade Journal. *w.* 12*s.* 6*d.* per year, post-paid. Manchester, Eng.
D. ..... Discovery. *w.* 8*s.* 8*d.*, post-paid. London.
E.....Engineering. *w.* 36*s.*, post-paid. London.
E E L....Electrical Engineer. *w.* 17*s.* 4*d.* per year, post-paid. London.
E G.....Engineers' Gazette. *m.* 4*s.*, post-paid. London.
E L.....Electricity. *w.* 6*s.* 6*d.*, post-paid. London.
El. .....Electrician. *w.* 24*s.* post-paid. London.
Elec.....Electricité. *w.* 15 *fr.* post-paid. Paris.
El P.....Electricien. *w.* 25 *fr.* post-paid. Paris.
Eng L...Engineer. *w.* 36*s.*, post-paid. London.
E P.....Electrical Plant. *m.* 6*s.* per year, post-paid. London.
E R L....Electrical Review. *w.* 21*s.* 8*d.* per year, post-paid. London.
F R.....Fortnightly Review. *m.* $4.50 per year. New York. London.
G C.....Génie Civil. *w.* 45 *fr.*, post-paid. Paris.
G E M...Gas Engineers' Magazine. *m.* 6*s.* 6*d.* per year, post-paid. Birmingham, Eng.
G W.....Gas World. *w.* 13*s.*, post-paid. London.
I.....Iron. *w.* 30*s.* per year, post-paid. London.
I C B....Illustrated Carpenter and Builder. *w.* 8*s.* 8*d.* per year, post-paid. London.
I E.....Indian Engineering. *w.* Rs. 18 per year, postage extra. Calcutta.
I L. ....Industries. *w.* 32*s.*, post-paid. London.
Inv ...Invention. *w.* 28*s.*, post-paid. London.
J G L....Journal of Gas Lighting. London.
J S A....Journal of the Society of Arts. *w.* London.
K.....Knowledge. *m.* 6*s.*, post-paid. London.
M.....Machinery. *m.* 9*s.*, post-paid. London.
M E.....Marine Engineer. *m.* 7*s.* 6*d.* per year, post-paid. London.
M E & E J. Manufacturers' Engineering and Export Journal. *m.* London.
M I.....Moniteur Industriel. *s-w.* 40 *fr.* per year, post-paid. Paris.
M W....Mechanical World. *w.* 8*s.* 8*d.* per year, post-paid. London.
N..... Nature. *w.* $7, post-paid. London.
N C.....Nineteenth Century. *m.* $4.50 per year. New York. London.
P Eng...Practical Engineer. *w.* 10*s.* per year, post-paid. London.
Rev R...Review of Reviews. *m.* $2.50. New York. London.
R N.....Railway News. London.
R U M...Revue Universelle des Mines. *m.* 40 *fr.* per year, post-paid. Paris.
R W.....Railway World. *m.* $3, post-paid. London.
S L.....Steamship. *m.* Leith, Scotland.
S R.....Sanitary Record. *m.* London.
W R.....Westminster Review. *m.* $4.50 per year. N. Y. London.

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*8025. The Choice of an Architect. Bernard McEvoy (E Mag–Jan.) 3000 w.

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†8059. Michael Angelo. Mrs. Ross (N C–Nov.) 7000 w.

8060. Benefits of Organization. W. H. Sayward (C & B–Nov.) 1000 w.

8061. Metal, Lath and Cement Construction. Ill. (C & B–Nov.) 1700 w.

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8672. Paints and Painting Materials. Wm. C. Wilson (A & B–Dec. 10.) 5800 w.

8693. Architectural Problems in Great Cities. Barr Ferree (A A–Dec. 10.) 7800 w.

8703. Blunders of Fireproofing. L. R. Tinsley (F W–Dec. 10.) 2000 w.

†8803. The English Revival of Decorative Art. Walter Crane (F R–Dec.) 7000 w.

Serials.

2285. Construction. Ill. M. Viollet-le-Duc (A A–Began Feb. 13—16 parts to date—15 cts. each).

6415. Bucrania. Ill. (A A–Began Sept. 3—3 parts to date—15 cts. each).

6850. Influence of Greek Architecture in the United States. Ill. W. H. Goodyear (Ch–Began Oct.—Ended Dec.—3 parts—30 cts. each).

6890. Girders or Beams with Solid Webs. Ill. Henry Cherry (P Eng–Began Sept. 16.—5 parts to date—30 cts. each).

7121. Office Help for Architects. Ill. George Hill (A A–Began Oct. 8.—3 parts to date—15 cts. each).

8220. Bricks and Joints in Brickwork (B B–Began Sept.—1 part to date—30 cts).

8503. The Champagne School of Architecture. Ill. P. Planat (A A–Began Dec. 3.—2 parts to date—15 cts. each).

8629. Les Constructions Coloniales. Ill. Bernard et Labussière (G C–Began Nov. 12—Ended Nov. 19—2 parts—30 cents each).

8695. Architecture (N W–Began Nov.—1 part to date—30 cts.)

CIVIL ENGINEERING.

*8026. Geology and the Mississippi Problem. A Southern Engineer (E Mag–Jan.) 3000 w.

8071. Wood Paving. Ill. (S R R–Nov.) 1200 w.

†8077. Palar Bridge, Vellore. Ill. K. Horgan-E. (I E–Oct. 15.) 300 w.

†8078. Head Works, Ganges Canal. Ill. (I E–Oct. 15.) 200 w.

8109. Street Pavements in Brussels, Rotterdam and Amsterdam. Louis H. Gibson (P–Nov.) 1000 w.

8110. Suitable Clays and Processes of Making Paving Brick (P–Nov.) 3000 w.

8112. Street Paving in St. Louis. Thos. H. Maklind (P–Nov.) 2000 w.

8113. Street Subways for Pipes and Wires at Nottingham, England. A. Brown (P–Nov.) 1500 w.

8122. Some Disputed Problems of Highway Construction (E R–Nov. 19.) 2500 w.

8136. An Old Revetment Wall. Ill. J. W. Sproule (R G–Nov. 18.) 1500 w.

8144. Tunnel Construction from Numerous Headings. Ill. (R A–Nov. 18.) 750 w.

*8173. Abstract of the Presidential Address of Mr. Harrison Hayter, to the Institution of Civil Engineers (E–Nov. 11.) 1200 w.

*8175. Steel Needles in Tunnel Driving (I–Nov. 11.) 500 w.

*8216. Cork Pavement (S R–Nov. 15.) 1800 w.

*8270. The Canadian Sault Canal (R M–Nov.) 900 w.

8301. The Duluth-Chicago-Buffalo Ship-Channel (E R–Nov. 26.) 700 w.

*8309. European Canals (E–Nov. 18.) 1200 w.

8326. The Jack Knife Bridge. Ill. (R A–Nov. 25.) 1500 w.

*8353. Strains in Portal of Through Bridges. Ill. Albert H. Howland (J A E S–Oct.) 700 w.

*8406. A Russian Highway Bridge. Ill. (R A E J–Dec.) 400 w.

8419. Expansion Joint—Memphis Bridge. Ill. (E N–Dec. 1.) 450 w.

8431. The Nicaragua Canal. Editorial (M R–Dec. 2.) 1000 w.

8474. Col. Albert A. Pope. Ill. (E & R–Nov.) 2000 w.

8491. The Ship Canal Across the Isthmus of Corinth. Ill. (M & B–Nov.) 450 w.

*8525. The Panama Canal Directors. Editorial (E–Nov. 25.) 2700 w.

†8546. Hot Tests for Determining Change of Volume in Portland Cement, with Discussion. Ill. W. W. Maclay (T C E-Oct.) 17,000 w.

†8547. A Method of Tunnel Alignment, with Discussion. Ill. H. F. Dunham (T C E-Oct.) 5000 w.

†8548. Combination Bridge Building on the Pacific Coast. Ill. Alfred D. Ottewell (T C E-Oct.) 1600 w.

†8549. Some Notes on Foundation Experiences. Ill. A. P. Boller (T C E-Oct.) 3000 w.

*8551. The Kioto Canal, Japan. Ill. (I L-Nov. 25.) 350 w.

†8600. The Dhunowri Works—Ganges Canal. Ill. (I E-Nov. 5.) 450 w.

8651. A Cantilever Highway Bridge with Curved Bottom Chords. Ill. (E N-Dec. 8.) 300 w.

8657. Some Facts of Experience in Pile-Driving. W. B. W. Howe, Jr. (E N-Dec. 8.) 2000 w.

8661. Cements. H. F. Bryant (M N-Dec. 1.) 800 w.

8662. Pile Driving. D. (M N-Dec. 1.) 800 w.

*8669. The Roads of Ancient America. Edw. W. Perry (G R-Nov.) 1200 w.

*8670. Street Improvement in Dunkirk, N. Y. Ill. Geo. E. Blackham (G R-Nov.) 1800 w.

*8671. Macadam and Telford Roads. Ill. Isaac B. Potter (G R-Nov.) 2700 w.

†8689. A Description of Some Repeated Stress Experiments. Ill. Jerome Sondesicker (T Q-April-July.) 3000 w.

†8690. Proposed New Formula for Yellow Pine Posts. Ill. J. H. Stanwood (T Q-April-July.) 400 w.

8697. Cedar Block Pavements (E R-Dec. 10.) 1400 w.

*8724. The Garibaldi Bridge over the River Tiber at Rome. Ill. (I L-Dec. 2.) 300 w.

*8738. "Overburnt" Cement (Eng L-Dec. 2.) 2500 w.

Serials.

7061. Maximum Stresses from Moving Single Loads in the Members of Three-Hinged Arches. Ill. Emrick A. Werner (J F I-Began Oct.—3 parts to date—45 cts. each).

7773. How the Earth is Measured. J. Howard Gore (J F I-Began Nov.—Ended Dec.—2 parts—45 cts. each).

8624. A Propos du Canal de Nicaragua. Ill. Fr. Mange (G C-Began Nov. 5—Ended Nov. 12—2 parts—30 cents each).

ELECTRICAL MISCELLANY.

8034. A Lecture Apparatus for Illustrating the Elementary Principle of Dynamos and Motors. Ill. Carl Hering (E W-Nov. 19.) 1600 w.

8037. The Tudor Accumulator in Central Stations. Ill. Paul Schoop (E E N Y-Nov. 16.) 2000 w.

8039. A New Standard Ballistic Galvanometer with Variable Sensibility and without "Drift." Ill. E. G. Willyoung (E E N Y-Nov. 16.) 2600 w.

8041. Unipolar Dynamo Construction. Ill. Edw. C. Boynton, Jr. (E E N Y-Nov. 16.) 1500 w.

8045. The Tank Lightning Arrester as an Adjunct for Street Railway Power Houses. Ill. A. J. Wurts (E E N Y-Nov. 16.) 1300 w.

8085. A Proposed Solution for the Electrical Hazard Problem. Geo. P. Low (W E-Nov. 19.) 3000 w.

*8155. Researches on Dissociation Constants (E R L-Nov. 11.) 1500 w.

*8156. The Specific Inductive Capacity of Electrolytes. Ill. (E R L-Nov. 11.) 900 w.

*8180. Electric Launches. C. E. Masterman (E L-Nov. 11.) 1700 w.

*8182. Improvements in the Leclanché Battery. Ill. (El-Nov. 11.) 1200 w.

*8184. Earthing the Middle Conductor of a Three-Wire System. Von Ph. Senbel (El-Nov. 11.) 700 w.

8204. The Largest Electrical Projector in the World. Ill. (E E N Y-Nov. 23.) 250 w.

8208. Electricity at the World's Fair up to Date. Ill. W. F. Collins (E E N Y-Nov. 23.) 6000 w.

8211. The Problem of Eccentric Cylinders. Ill. A. E. Kennelly (E W-Nov. 26.) 1500 w.

*8221. On the Determination of Temperature by the Change in the Electrical Resistance of Conductors. Ill. G. C. Farkell and H. G. Hamman (S J E-Nov.) 2000 w.

8235. An Improved System of Electric Burglar Alarm, with Transmitting, Recording and Line Stamp Attachment, in Operation at the Security Safe Deposit Vaults, Equitable Building, Boston. Ill. (E N Y-Nov. 23.) 3000 w.

8236. Electric Cranes. Ill. (E N Y-Nov. 23.) 700 w.

8244. A Thermo-Electric Pyrometer. George West (S E-Nov. 19.) 500 w.

*8290. The Generation of Electric Motive Force in the Coal Fields (C G-Nov. 18.) 1700 w.

*8296. Fuse Wires. Ill. C. P. Feldmann (El-Nov. 18.) 300 w.

*8297. The Ewing Magnetic Curve Tracer. Ill. (El-Nov. 18.) 900 w.

*8298. On the Dissipation of the Electrical Energy of the Hertz Resonator. Ill. V. Bjerknes (El-Nov. 18.) 800 w.

*8305. Causes of Sparking of Dynamo Brushes (E L-Nov. 18.) 600 w.

*8320. Electrostatic Alternators. Ill. T. H. Muras (E R L-Nov. 18.) 900 w.

*8321. The Induction Motor: Who Invented it? Ill. R. Kennedy (E R L-Nov. 18.) 1308 w.

8332. Inexpensive Electric Motors. Ill. (M S R-Nov. 24.) 900 w.

8344. The Use of Compound Wound Generators from a Practical Point of View. W. M. Willis (E W-Dec. 3.) 1500 w.

8380. Ball Dynamos, and How They Are Made. Ill. Leslie W. Collins (E E N Y–Nov. 30.) 2800 w.

8383. Future Developments in Electricity. G. Emil Hesse (E N Y–Nov. 30.) 800 w.

†8401. Should the Positive or Negative Pole of a Generator be Grounded? (S R J–Dec.) 800 w.

8443. An Electric Excavator. Ill. (W E–Dec. 3.) 850 w.

8444. Electric Signaling Through Fire Hose (W E–Dec. 3.) 300 w.

8492. Nikola Tesla and his Business. Ill. George Iles (M & B–Nov.) 2000 w.

8494. Electric Possibilities. W. W. Jacques (M & B–Nov.) 1500 w.

8498. Multipolar Dynamos. Ill. (P S–Dec.) 1200 w.

*8513. Factory Driving by Electricity (Eng L–Nov. 25.) 4000 w.

8531. Notes on the Effect of Harmonics in the Transmission of Power by Alternating Currents. Henry A. Rowland (E W–Dec. 10.) 1800 w.

8535. The Modern Development of the Dynamo. Ill. W. Kohlrausch (E W–Dec. 10.) 1200 w.

8536. A Universal Transformer. Ill. Guilio Appolonj (E W–Dec. 10.) 1400 w.

8537. Performance of an Overhead Traveling Crane, Operated by a Single Electric Motor. Anthony Victorin (E W–Dec. 10.) 800 w.

*8569. On the Possible Occurrence of Torsion Currents in the Cores of Transformers. Fred. T. Trouton (El–Nov. 25.) 700 w.

*8572. Electric Motors in Factories. R. H. Housman (El–Nov. 25.) 2400 w.

8581. A New Method of Field Excitation. Ill. H. L. Tyler (E E N Y–Dec. 7.) 500 w.

8582. The First Electrical Treatise of Galvani. Ill. Park Benjamin (E E N Y–Dec. 7.) 900 w.

8583. The New Lundell Motor. Ill. (E E N Y–Dec. 7.) 900 w.

*8603. Le Développement des Accumulateurs. Ill. F. Géraldy (Elec–Nov. 3.) 1500 w.

*8604. Essais d'Accumulateurs (Elec–Nov. 10.) 1300 w.

*8605. Transformateur F. Lucas. Ill. F. Guilbert (Elec–Nov. 10.) 700 w.

*8612. La Recherche des Court-Circuits dans les Bobines. E. Meylan (El P–Nov. 5.) 700 w.

*8614. Recherches Electriques de l'Institut Physique et Technique de l'Empire d'Allemagne, à Charlottenbourg. Ill. Dr. St. Lindeck (El P–Nov. 5.) 2200 w.

*8615. Nouvelle Pile à l'Ecoulement Continu. Ill. E. M. (El P–Nov. 5.) 500 w.

*8616. La Distribution de l'Energie Electrique à Gênes. Ill. E. Jorel (El P–Nov. 12.) 2500 w.

*8625. Controleur Electrique de Rondes, Système de Poulpiquet. Ill. L. Viennot (G C–Nov. 5.) 1300 w.

8664. Taxation of Electrical Manufacturing Corporations (W E–Dec. 10.) 550 w.

8665. Electricity in Japan. Ill. Kunihiko Iwadare (W E–Dec. 10.) 1400 w.

†8686. Commercial Electricity. H. C. Spaulding (T Q–April-July.) 5000 w.

†8687. Long-Distance Transmission of Power by Electricity. Ill. Francis R. Hart (T Q–April-July.) 1600 w.

*8709. Results of Tests Made to Ascertain the Influence of the Installations of the Berliner Elektrizatats Werke on Telephone Lines. Ill. (E L–Dec. 2.) 1500 w.

*8713. On the Attraction of Infinite Elliptic Cylinders. Geo. A. Gibson (E E L–Dec. 2.) 3000 w.

*8715. A New Electrical Distribution System. Ill. (E E L–Dec. 2.) 1000 w.

*8720. Is the Earth a Reservoir of Electricity? Sydney F. Walker (E R L–Dec. 2.) 1500 w.

*8721. Alternating Currents and the E. M. F. Quantity Diagram. Ill. Arthur Whitwell (E R L–Dec. 2.) 4000 w.

*8722. Note on the Wheatstone Bridge. Ill. Arthur Whitwell (E R L–Dec. 2.) 100 w.

*8723. Improvements in Electrical Distribution. Ill. (E R L–Dec. 2.) 1000 w.

8760. Some Fallacies in Dynamo and Motor Design. Ill. F. B. Crocker (E W–Dec. 17.) 1100 w.

8761. The Death of Dr. Werner Siemens. Ill. (E W–Dec. 17.) 600 w.

*8781. Embrayage Magnétique de Bovet. Ill. P. Clémenceau (El P–Nov. 26.) 1100 w.

*8783. Nouvelle Disposition de Piles à Alimentation Automatique, Système Jeanty. Ill. (El P–Nov. 26.) 2100 w.

8793. A Curve for Ascertaining the Ampere-Turns Required for Magnetic Saturation. Ill. Chas. Steinmetz (E E N Y–Dec. 14.) 200 w.

8795. The Sheridan Electric Power and Office Building, Denver, Col. Ill. (E E N Y–Dec. 14.) 1200 w.

8797. On a Novel Type of Unipolar Machine. Ill. Wm. A. Carey (E E N Y–Dec. 14.) 800 w.

8798. Leonard's System of Control for Electric Traveling Cranes. Ill. (E E N Y–Dec. 14.) 600 w.

Serials.

2784. Insulated Electric Conductors. Ill. James Bowstead Williams (E E N Y–Began March 16—14 parts to date—15 cts. each).

3500. Theoretical Elements of Electro-Dynamic Machinery. Ill. A. E. Kennelly (E E N Y–Began Apr. 20—13 parts to date—15 cts. each).

6631. A Biographical Sketch of the Khotinsky Accumulator. Ill. A. de Khotinsky (E E N Y–Began Sept. 14—Ended Nov. 30—8 parts—15 cts. each).

8038. Increased Commercial Efficiency and Higher Economy in Central Stations. J. H.

Vail (E E N Y–Began Nov. 16—Ended Dec. 7—4 parts—15 cts. each).

8185. The Electro-Magnetic Theory of Light. James H. Gray (E E L–Began Nov. 11—Ended Nov. 18—2 parts—30 cts. each).

8213. Experimental Studies of the Differences of Potential Generated Through Contact of Metals, Liquids and Dry Electrolytes. Ill. Walter Negbauer (E W–Began Nov. 26—Ended Dec. 17—4 parts—15 cts. each).

8339. Applications of Electricity to Agricultural Work. Ill. (E W–Began Dec. 3—3 parts to date—15 cts. each).

8342. Electrical Needs of the Times. H. Franklin Watts (E W–Began Dec. 3—2 parts to date—15 cts. each).

8567. Electro-Chemical Effects on Magnetizing Iron. Ill. Thos. Andrews (E R L–Began Nov. 25—1 part to date—30 cts).

8571. Experimental Researches on Alternate Current Transformers. Ill. J. A. Fleming (El–Began Nov. 25—2 parts to date—30 cts. each).

8610. Courbes Périodiques de l'Arc à Courants Alternatifs. Ill. F. Guilbert (Elec–Began Nov. 17—Ended Nov. 24—2 parts—30 cts. each).

8753. Iron-Rust Possessing Magnetic Properties. A. Liversidge (I–Began Dec. 2—1 part to date—30 cts).

8778. Sur les Horloges Electriques. Ill. Henry de Graffigny (Elec–Began Nov. 1—1 part to date—30 cts).

ELECTRIC LIGHTING.

8044. The Electric Arc—Abstract of Lecture by R. S. Dobbie (E E N Y–Nov. 16.) 800 w.

8049. The Cost of Arc Lighting in Some Cities (S E–Nov. 12.) 350 w.

8084. Utilizing Water Power in Washington for Generating Electricity. Ill. (W E–Nov. 19.) 950 w.

*8157. Central Electric Works at Frankfort-on-the-Main (E R L–Nov. 11.) 3500 w.

*8158. The Cost of Electric Supply. John Hopkinson (E R L–Nov. 11.) 3700 w.

*8172. Electric Lighting of the Old America Exhibition, Manchester. Ill. (E–Nov. 11.) 1500 w.

*8178. Electric Lighting for Glasgow (E L–Nov. 11.) 1200 w.

*8179. The Leeds Arc Light System. Ill. (E L–Nov. 11.) 700 w.

8209. The Edison Lamp Patent Suit: A Preliminary Injunction Granted Against the Sawyer-Man Company (E W–Nov. 26.) 700 w.

8231. The Distribution and Measurement of Illumination, with Discussion. Ill. (E N–Nov. 24.) 3000 w.

8251. Electric Lighting in Chicago's Parks and Boulevards. Ill. (W E–Nov. 26.) 900 w.

8252. Electricity in Japan. Ill. (W E–Nov. 26.) 1800 w.

*8319. Electric Lighting at Graz (E R L–Nov. 18.) 500 w.

*8329. The Statue of Liberty. Ill. D. P. Heap (L Mag–Dec.) 1100 w.

8340. Separable or Detachable Incandescent Lamps. Ill. L. K. Böhm (E W–Dec. 3.) 2000 w.

8367. Three Systems of Electric Distribution. Ill. (Sc A–Dec. 3.) 900 w.

8375. The Lighting of Washington Park, Chicago. Ill. F. A. Sheffler (E E N Y–Nov. 30.) 1200 w.

*8566. Country House Lighting. Ill. (E R L–Nov. 25.) 1800 w.

*8570. Life and Efficiency Tests of Incandescent Lamps. Ill. Clarence P. Feldmann (El–Nov. 25.) 800 w.

*8573. The Manufacture of Electric Light Carbons. H. O. Fisk (P Eng–Nov. 25.) 2500 w.

8580. Arc Lamps for Optical Projection. Ill. R. S. Dobbie (E E N Y–Dec. 7.) 1000 w.

*8611. L'Eclairage Electrique du Nouvel Hotel des Postes de Bruxelles. Ill. Em. Dieudonné (El P–Nov. 5.) 2600 w.

*8617. L'Eclairage de la Caisse des Dépots et Consignations. P. Clémenceau (El P–Nov. 12.) 800 w.

*8618. La Lampe à Arc Desruelles et Chauvin. Ill. E. Meylan (El P–Nov. 12.) 1300 w.

*8639. Central Station of the East End Electric Light Company, Pittsburg. Ill. (E I–Dec.) 1600 w.

*8640. Water Tube Boilers for Electric Light and Railway Service. Ill. (E I–Dec.) 7000 w.

8666. Electric Lighting in the Saint Cyr Military Academy. Ill. (W E–Dec. 10.) 400 w.

*8710. Incandescence Lamp Manufacture in the United States. Ill. Leonard G. Tate (E P–Dec. 1.) 900 w.

†8717. Electric Carriage Lighting. E. E. (I E–Nov. 12.) 450 w.

*8719. The Abuse of Long-lived Incandescent Lamps. Ill. (El–Dec. 2.) 1000 w.

8746. Diving by Electric Light from a Storage Battery (S M–Dec. 1.) 600 w.

8796. The Life of Incandescent Lamps in Its Relation to Mercury and Metallic Vacuum Pumps. Ill. G. A. Frei (E E N Y–Dec. 14.) 1500 w.

Serials.

6709. Electric Light and Power. Arthur F. Guy (E E L–Began Sept. 9—9 parts to date—30 cts. each).

7186. Notes on the Fitting Up of Ships with the Electric Light. Alfred H. Gibbings (E L–Began Sept. 30—8 parts to date—30 cts. each).

8033. Some of the Uses of the Search Lights. R. H. Bacon (E W–Began Nov. 19—2 parts to date—15 cts. each).

8096. Economy in Electric Lighting T–Began Nov. 15—Ended Dec. 1—2 parts—(15 cts. each).

GAS ENGINEERING.

8055. Water Gas Condensation, with Discussion. John M. Rusby (P A–Nov. 15.) 2500 w.

8056. Do Small Gas Companies Need Consulting Engineers? with Discussion. C. A. White (P A–Nov. 15.) 2600 w.

†8076. Progress in Incandescent Lighting by Gas. F. (I E–Oct. 15.) 600 w.

*8079. The Utilization of Waste Steam in Gas Works. Norton H. Humphreys (J G L–Nov. 8.) 1200 w.

*8080. Discussion of Mr. Jones' Paper on "Stopped Ascension Pipes: Their Cause and Cure" (J G L–Nov. 8.) 2500 w.

*8081. Automatic Gas Meter. Ill. (J G L–Nov. 8.) 1400 w.

*8082. Gas Generator. Ill. (J G L–Nov. 8.) 1200 w.

8117. Natural Gas in Ontario (A M & I W–Nov. 18.) 2000 w.

8187. Improvements in Gas Lighting (M N–Nov. 15.) 450 w.

*8194. Recovery of Bye-Products from Coke Ovens (G W–Nov. 12.) 1000 w.

*8238. Purification, with Discussion. C. C. Carpenter (J G L–Nov. 15.) 9000 w.

*8239. Mr. William Young's New Oil-Gas Plant (J G L–Nov. 15.) 3500 w.

*8271. Herring's Carburetting Process (G W–Nov. 19.) 1100 w.

*8441. On Being Original, and on Originality in Gas Manufacture (J G L–Nov. 22.) 1700 w.

8467. Pumping of Street Drips. Ill. (P A–Dec. 1.) 500 w.

8468. The New Works of the San Francisco Gas Light Company. Ill. (P A–Dec. 1.) 1300 w.

8475. Sulphate of Ammonia as a Fertilizer. Paul Wagner (A G L J–Dec. 5.) 2000 w.

*8542. Fixing Sulphur in Coke. Walter J. May (C G–Nov. 25.) 1200 w.

*8587. On the Use of Oxygen in the Purification of Coal Gas. Harrison Veevers (J G L–Nov. 29.) 1700 w.

*8588. An Account of a Recent Explosion in a Tar Well. W. R. Chester (J G L–Nov. 29.) 1600 w.

*8613. Sur l'Echappement des Moteurs à Gaz. P. Simon (El P–Nov. 5.) 600 w.

Serials.

8506. Generation of Light from Coal Gas. V. B. Lewes (G W–Began Nov. 26—2 parts to date—30 cts. each).

HYDRAULICS.

8123. The Promotion and Early Management of a Water-Works System (E R–Nov. 19.) 1500 w.

8141. Laying of Flexible Water Pipes. Ill. (F W–Nov. 19.) 400 w.

8330. The Cavour Irrigation Canal in Italy. L. G. Carpenter (L P–Nov. 26.) 2000 w.

8331. Irrigation in Florida. John C. MacDonald (L P–Nov. 26.) 2200 w.

*8352. Stony Brook Improvement. Ill. Henry H. Carter (J A E S–Oct.) 6500 w.

*8355. Water Pipe and Pressures in Cities and Towns. W. F. Goodline (J A E S–Oct.) 5000 w.

8461. Progress of Irrigation. R. G. Morison (F W–Dec. 3.) 900 w.

8489. The Water Power of Maine (M G–Dec. 3.) 1400 w.

*8626. Les Eaux de Cayenne. Ill. Goldenstein (G C–Nov. 5.) 1200 w.

*8770. La Roue Pelton. Ill. T. C. H. (G C–Nov. 26.) 2100 w.

Serials.

7573. Fountains. Ill. Léon Benouville (A A–Began Oct. 29—3 parts to date—15 cts. each).

8521. The Periyar Irrigation Project. Ill. A. T. Mackenzie (E–Began Nov. 25—2 parts to date—30 cts. each).

INDUSTRIAL CHEMISTRY.

8137. Discrepancy in Chemical Work. C. B. Dudley (R G–Nov. 18.) 2500 w.

8496. Iron Pyrites (Min–Nov.) 1000 w.

*8768. Epuration des Eaux d'Egouts par le Sulfate Ferrique. A. & P. Buisine (M I–Nov. 29.) 1200 w.

INDUSTRIAL SOCIOLOGY.

*8022. Do We Need State-Bank Currency? Edward Atkinson (E Mag–Jan.) 3000 w.

*8029. The True Cause of Labor Troubles: A Reply to Chas. J. Harrah. John Gordon Gray (E Mag–Jan.) 3000 w.

8052. Profit Sharing. N. O. Nelson. With Editorial (A M–Nov. 17.) 1800 w.

†8057. The Labor Question. J. Chamberlain (N C–Nov.) 15,000 w.

8093. Theodore Voorhees on the Buffalo Strike. Editorial (L F M–Nov.) 3500 w.

8098. Weak Places in Labor Unions. Editorial (T–Nov. 15.) 1500 w.

8154. Incompetence in High Power. Editorial (So L–Nov. 15.) 1000 w.

*8174. Labor in Italy (E–Nov. 11.) 2200 w.

8186. The Status of the Workingman. C. Alden Schaeffer (A Ar–Nov. 19.) 2500 w.

8245. Address of C. W. Naylor, President of the National Association of Stationary Engineers (S E–Nov. 19.) 1300 w.

†8338. The Problem of Poverty. Washington Gladden (C M–Dec.) 10,000 w.

†8437. Compulsory Arbitration. Lyman Abbott (F–Dec.) 2500 w.

†8438. Government Ownership of Railways. T. V. Powderly (F–Dec.) 2000 w.

†8439. Are We Socialists? Thos. B. Preston (F–Dec.) 3500 w.

†8518. Fallacies of Modern Economists. Arthur Kitson (P S M–Dec.) 7500 w.

*8684. The Law (?) of Supply and Demand. A. B. Woodford (S Ec–Dec.) 3000 w.

†8763. The Unemployed. John Burns (N C–Dec.) 9500 w.

†8764. Mr. Chamberlain's Programme. Thos. Burt, H. H. Champion, J. K. Hardie, S. Woods (N C–Dec.) 17,000 w.

†8766. £38,000,000 per Annum. Jesse Collings (N C–Dec.) 3500 w.

*8771. Etude sur les Brevets d'Invention. Dumoustier de Frédilly (G C–Nov. 26.) 3500 w.

†8788. The Consolidation of Capital. Wm. Nelson Black (I R W–Dec. 15.) 2000 w.

Serials.

7918. Labor and Contract. R. W. R. (E M J–Began Nov. 12—2 parts to date—15 cts. each).

8384. Decisions under the Sherman Law (E N Y–Began Nov. 30—2 parts to date—15 cts. each).

LANDSCAPE ENGINEERING.

8032. Landscape Art as a Profession (G & F–Nov. 16.) 1000 w.

8203. Color for the Lawn in November. R. M. T. (G & F–Nov. 23.) 800 w.

8574. Llewellyn Park. Ill. (G & F–Dec. 7.) 900 w.

8800. New England Parks. M. C. Robbins (G & F–Dec. 14.) 2500 w.

MARINE ENGINEERING.

8053. The Chase Elevator. Ill. (Sea–Nov. 17.) 1200 w.

8054. Baltimore's Popular Shipyard. The Plant of Messrs. Wm. E. Woodall and Company. Ill. (Sea–Nov. 17.) 1200 w.

8074. American Steamship Savannah. Ill. (Am S–Nov. 17.) 1300 w.

*8086. The Siamese Yacht Cruiser, Mahra Chakrkri (R S P–Oct.) 600 w.

*8087. An Unenviable Position at Sea. (R S P–Oct.) 1300 w.

8090. Four Sets of Propelling Engines for the New Nine Thousand-Ton Cruiser (S V–Nov. 15.) 1200 w.

8153. Strengthening Steel Vessels. Editorial (I T R–Nov. 17.) 600 w.

*8161. The Competition of British Ports for Shipping Business (Eng L–Nov. 11.) 1800 w.

*8162. Floating of H. M. S. Royal Oak (Eng L–Nov. 11.) 2000 w.

*8193. Corrosion in Marine Boilers. J. H. Paul (P Eng–Nov. 11.) 900 w.

*8200. Our Torpedo Flotilla and Navy. Robert McGlasson (I L–Nov. 11.) 650 w.

8250. Iron vs. Wooden Ships. C. F. Swan (M S P–Nov. 19.) 1500 w.

*8293. The Argentine Twin Screw Armor-Clad Ram Libertad (Eng L–Nov. 18.) 2800 w.

*8294. Stern-Wheel Steamer for the French Government. Ill. (Eng L–Nov. 18.) 700 w.

*8295. The Future of the Atlantic Editorial (Eng L–Nov. 18.) 2400 w.

8385. The First Whaleback Passenger Steamer. Ill. (Sea–Dec. 1.) 2300 w.

8386. Whalebacks. Record and Dimensions of Vessels Built (Sea–Dec. 1.) 200 w.

8387. The Great Dry Dock at Superior. Ill. (Sea–Dec. 1.) 800 w.

8388. Rapid Increase in the Ore and Coal Carrying Trade (Sea–Dec. 1.) 2500 w.

8390. Electric Torpedo Boats (S M–Nov. 15.) 550 w.

8483. Marine Engine Design. W. F. Durand (M R C–Dec. 1.) 1000 w.

8484. A Lake-Built Ocean Tug. Ill. (M R C–Dec. 1.) 1000 w.

8485. Visibility of Red, White and Green Lights (M R C–Dec. 1.) 1000 w.

8486. Important Features in the Five-Day Steamers (M R C–Dec. 1.) 300 w.

*8514. Monitors as Harbor-Defence Ships. Editorial (Eng L–Nov. 25.) 1000 w.

8591. Hollow-Shafting in Modern Steamships. Ill. (Ir Age–Dec. 8.) 900 w.

*8594. The Development of the Machinery of Atlantic Liners. Arthur J. Maginnis (S L–Dec.) 3000 w.

*8595. The Efficiency of Screw Propellers. Wm. G. Walker (S L–Dec.) 2000 w.

8649. The Launch of the Whaleback Passenger Steamer Christopher Columbus. Ill. (Sea–Dec. 8.) 900 w.

8663. A South American Passenger Steamer. Ill. W. N. B. (M N–Dec. 1.) 900 w.

8667. The Baker Submarine Boat in Chicago Waters (W E–Dec. 10.) 1200 w.

*8706. The Austrian Lloyds' New Steamer, "Gisela." Ill. (M E–Dec. 1.) 700 w.

*8707. The Steamer Yacht "Queen." Ill. (M E–Dec. 1.) 150 w.

*8739. The Russian Navy.—The Ruric. Ill. (Eng L–Dec 2.) 400 w.

*8744. How it Happened the Anchor Liner Roumania Was Lost (E G–Dec.) 800 w.

8749. A Novel Cargo Steamer (R R–Dec. 10.) 800 w.

*8772. Touage par Adhérence Magnétique, Système de Bovet. Ill. H. Boileau (G C–Nov. 26.) 5400 w.

8805. The Ludlow-Heyerman Lighthouse Board Controversy. Alex. R. Smith (Sea–Dec. 15.) 3500 w.

8808. Steamship Efficiency. A Naval Officer (Ir Age–Dec. 15.) 1500 w.

8809. The Turrets of the Battle Ships (Ir Age–Dec. 15.) 800 w.

Serials.

8621. Les Bateaux Sous-Marins. L. de Djeri (M I–Began Nov. 8—Ended Nov. 15—2 parts—30 cents each).

MECHANICAL ENGINEERING.

8051. Why are Gears Noisy? (A M–Nov. 17.) 700 w.

8188. Something about Whetstones (M N–Nov. 15.) 600 w.

8189. The Care of Small Saws (M N–Nov. 15.) 900 w.

8234. American and British Workmen and Machinery. J. Arthur (A M–Nov. 24.) 3500 w.

8246. The Making of Specifications for Structural Material. Chas. B. Dudley (A M & I W–Nov. 25.) 700 w.

*8283. Whetstones in the United States. L. S. Griswold (S–Nov.) 2500 w.

*8299. Comparison of the Friction of Cotton Mill Engines and Gearing to the Actual Work Done. Alfred Saxon (El–Nov. 18.) 3400 w.

*8322. Water Motors. A. L. Steavenson (E R L–Nov. 18.) 750 w.

8374. A New Compound Triangle. Ill. (C–Dec.) 500 w.

8395. Wire Stretcher and Splicer. Ill. (I Age–Nov. 15.) 450 w.

8410. An Automatic Oil Separator. Ill. (E R–Dec. 3.) 800 w.

*8442. German Method of Manufacturing Belts (L M–Dec. 1.) 1000 w.

*8558. New Process of Cutting Cams. Ill. W. A. Gabriel (E M–Dec.) 1800 w.

*8559. Strains in the Rims of Fly-Band Wheels Produced by Centrifugal Force. Ill. J. B. Stanwood (E M–Dec.) 1500 w.

*8560. Variable Speed Power Transmission. Ill. H. C. Spaulding (E M–Dec.) 1000 w.

Serials.

7865. Notes on Rope Driving. Ill. M. E. (A M–Began Nov. 10—2 parts to date—15 cts. each).

8092. Friction and Lubrication. Albert D. Pentz (M R–Began Nov. 18—2 parts to date—15 cts. each).

8318. Principles, Curiosities, Possibilities and Limitations of the Crank Motion. Leicester Allen (Eng–Began Nov. 26—2 parts to date—15 cts. each).

8370. Pneumatic Pumping Apparatus. Ill. (Ir Age–Began Dec. 1—2 parts to date—15 cts. each).

8550. Centrifugal Pumps. Ill. G. R. Bodmer (I L–Began Nov. 25—1 part to date—30 cts).

METALLURGY.

8120. Cast Iron vs. Wrought Iron and Steel in Building Columns. Editorial (E R–Nov. 19.) 500 w.

*8164. The Tallest Wrought-Iron Chimney in Great Britain. Ill. (Eng L–Nov. 11.) 1000 w.

*8169. Royalty Owners and Ore Concentration. Walter J. May (C G–Nov. 11.) 1400 w.

8218. Prospects for Making Southern Steel (M R–Nov. 25.) 1000 w.

8257. Nickel Analysis. Stephen H. Emmens (E M J–Nov. 26.) 1400 w.

8260. The First Iron Casting Made in America (B J C–Nov. 26.) 1200 w.

8273. About a New Process (M I T–Nov. 24.) 800 w.

*8277. On Iron Alloys. (N–Nov. 17.) 2000 w.

*8291. Coal Waste and its Remedy, Particularly in Regard to Coal Used in Iron Manufacture. Walter J. May (C G–Nov. 18.) 3800 w.

*8300. The Metallurgy of Iron and Steel Manufacturing Processes.—Abstract of Paper by T. Turner (P Eng–Nov. 18.) 1400 w.

*8317. The Application of the Le Chatelier Pyrometer to Blast Furnaces. Charles Lowthian Bell (I–Nov. 18.) 2200 w.

*8357. The Desilverisation of Lead Slags. H. A. Keller (A M S–Oct. 15.) 800 w.

*8362. Pneumatic Separation. Walter J. May (A M S–Oct. 22.) 1200 w.

8371. The Wittgenstein Sheet Mill. Ill. (Ir Age–Dec. 1.) 800 w.

8372. Colorado Steel Rail Production (Ir Age–Dec. 1.) 600 w.

8471. A Concise Review of the Possibilities of Steel Making in the Southern States. A. M. Shook (T–Dec. 1.) 1600 w.

8495. Iron in Ancient Egypt. Henry Brugsch (M S R–Dec. 1.) 500 w.

8508. A Volumetric Method for the Determination of Lead. F. C. Knight (M I T–Dec. 1.) 1800 w.

†8519. Nickel and Its Uses. J. T. Donald (P S M–Dec.) 2500 w.

†8544. Hardening Structural Steel. Ill. A. C. Cunningham, and The Results Obtained from Tests of Full Sized Steel Eye-Bars, with Discussions (T C E–Oct.) 20,800 w.

†8545. Experiments on Iron and Steel Joints, Riveted on an Angle. Ill. Bertram B. Flint (T C E–Oct.) 1200 w.

*8565. Comparison of Cost of Electric and Forge Welding. F. P. Royce (M W–Nov. 25.) 900 w.

*8622. La Fabrication des Fils d'Acier Bessemer. G. P. Clapp (M I–Nov. 15.) 1100 w.

†8634. Note sur la Fabrication de l'Acier par le Procédé Thomas et Gilchrist. F. Tordeur (R U M–Oct.) 7000 w.

†8635. Note sur un Nouveau Procédé de Fabrication des Fils Métalliques. Ill. Joseph Goffin (R U M–Oct.) 1900 w.

8643. The First Casting Made in America. Ill. (A M–Dec. 8.) 2800 w.

8674. Saniter's Process for the Elimination of Sulphur from Pig Iron and Steel (E M J–Dec. 10.) 1200 w.

8675. Mills on the Lahn, Nassau, Germany. Ill. John W. Meir (E M J–Dec. 10.) 1200 w.

8676. Non-uniformity of Iron Made in One Cast. Morton Stevens (E M J–Dec. 10.) 900 w.

†8688. Magnetic Concentration of Iron Ore. Harvey S. Chase (T Q–April–July.) 2500 w.

*8726. The Relative Corrodibility of Pure and Impure Lead (I L–Dec. 2.) 700 w.

*8732. The Iron Industry of Spain. Editorial (E–Dec. 2.) 1700 w.

*8745. The Copper Resources of the United States, with Discussion. James Douglas (J S A–Dec. 2.) 13,500 w.

Serials.

6033. Variations in the Milling of Gold Ore. T. A. Rickard (E M J–Began Aug. 27—Ended Dec. 10—5 parts—15 cts. each).

7325. The Elimination of Sulphur from Iron. G. E. Stead (E M J–Began Oct. 15—Ended Nov. 26—6 parts—15 cts. each).

7680. The Freiburg Works, Germany (A M S –Began Sept. 24—5 parts to date—30 cts. each).

7739. The Basic Bessemer Steel Plant of the Pottstown Iron Company. Joseph Hartshorne (E M J–Began Nov. 5—Ended Nov. 19—3 parts—15 cts. each).

7854. The Concentration of Iron Ores. Walter J. May (Inv–Began Oct. 29—4 parts to date—30 cts. each).

8289. The Iron Industry of the British Colonies.—Its Position and Prospects (C G–Began Nov. 18—3 parts to date—30 cts. each).

8807. Tin Plate.—The Methods of Manufacture in Wales. Ill. (Ir Age–Began Dec. 15 —1 part to date—15 cts.)

MILITARY ENGINEERING.

*8163. The Brown Segmental Wire-Wound Gun. Ill. (Eng L–Nov. 11.) 2200 w.

8249. Breech-Loading Rifled Mortars. Ill. (I T R–Nov. 24.) 1000 w.

8422. The Line and Staff of the Navy. Editorial (E N–Dec. 1.) 1000 w.

†8685. The Construction of Modern Breech-Loading Rifled Mortars Ill. A. H. Russell (T Q–April–July.) 4000 w.

*8752. The Manufacture of Small Arms (I–Dec. 2) 1300 w.

Serials.

8241. Assault and Battery. A. Ewbank (I E–Began Oct. 22—2 parts to date—45 cts. each).

MINING.

*8027. The Anthracite Coal Industry. Ill. H. M. Chance (E Mag–Jan.) 3000 w.

8075. The Canadian Asbestos Industry (R & T–Nov.) 800 w.

8111. Classifications of Asphalts. Julius Schubert (P–Nov.) 1400 w.

8118. The Measured or Weighed Ton or Bushel (A M & I W–Nov. 18.) 900 w.

8130. The Shaw Mine, Eldorado County, California. C. A. Aaron (E M J–Nov. 19.) 800 w.

8134. The Ventilation of Fiery Mines. M. Rateau (M S R–Nov. 17.) 2000 w.

8140. The Coal Business of the Northwest (R G–Nov. 18.) 1000 w.

*8168. The Hours of Work in Coal Mining (C G–Nov. 11.) 1500 w.

8195. The Pedigree of Asbestos (A S–Nov. 19.) 400 w.

8217. The Florida Phosphate Industry. Edward Willis (M R–Nov. 25.) 1600 w.

8225. American Tin Mines. Stephen H. Emmens (E N–Nov. 24.) 2000 w.

8248. Mode of Occurrence of Mesaba Ore. H. V. Winchell (I T R–Nov. 24.) 1500 w.

8254. The Comparative Efficiency of Compressed Air and Electricity. Francis A. Pocock (E M J–Nov. 26.) 900 w.

8256. The Great Falls Works of the Boston and Montana Consolidated Copper and Silver Mining Company. From Report of Frank Klepetko (E M J–Nov. 26.) 1500 w.

8274. The Latest Great Mining Camp. Ill. (M I T–Nov. 24.) 4500 w.

8333. The Resources of Alaska (M S R–Nov. 24.) 900 w.

8346. The Hydraulic Gravel Elevator System. Ill. (M S P–Nov. 26.) 1000 w.

8347. The Miner's Influence in Civilization—Senator Stewart's Speech before the California Mining Convention (M S P–Nov. 26.) 3000 w.

8348. Spontaneous Combustion in Mines (Sc–Nov. 25.) 950 w.

*8358. The Wentworth Proprietary Company's Gold Mine, Lucknow. (N. S. W.) Ill. (A M S–Oct. 15.) 3500 w.

*8360. The Geological Occurrence of the Broken Hill Lode. Ill. (A M S–Oct. 22.) 1300 w.

8365. A Mining Plant in the San Juan Country. J. C. Kelso (S E–Nov. 26.) 1800 w.

8433. The Scope and Personnel of the Mining Census. D. T. Day (E M J–Dec. 3.) 2400 w.

8436. The Mines of the Mary Lee Coal Company, Ala. (E M J–Dec. 3.) 2000 w.

*8477. The Development of a New West Virginia Coal Field. Walter Graham (C E–Dec.) 1800 w.

*8478. Proposed Mine Law (C E–Dec.) 13,500 w.

8479. The Gas Wells of Sze Chuen, China (A M & I W–Dec. 2.) 1500 w.

8493. Mining at the Fair (M & B–Nov.) 1200 w.

8497. Baltic Amber Mines (Min–Nov.) 500 w.

*8502. Lake Huron Minerals. Robert Bell (I–Nov. 25.) 4000 w.

8509. The Great Mines of Mount Sneffles. C. L. Hall (M I T–Dec. 1.) 1500 w.

*8540. The Protection of Electric Light and Power Cables in Mines. Sydney F. Walker (C G–Nov. 25.) 3000 w.

*8543. The Thickest Coal Bed Yet Proved (C G–Nov. 25.) 3000 w.

†8636. Notice sur le Bassin Houiller d'Héraclée (Turquie d'Asie). Ill. J. d'Harveng (R U M–Oct.) 9000 w.

8673. The Harshaw Mine, Arizona (E M J-Dec. 10.) 800 w.

8678. New Canadian Iron Fields. R. A. Parker (E M J-Dec. 10.) 800 w.

*8733. The Effects of Blown-out Shots in Fiery Mines (C G-Dec. 2.) 3500 w.

*8735. Colliery Management in Germany and in England (C G-Dec. 2.) 1000 w.

*8736. The Relative Values of Clean and Dirty Fuels. Walter J. May (C G-Dec. 2.) 1400 w.

†8754. Preliminary Examination of So-called Cannel Coal from the Kootanie of British Columbia. D. P. Penhallow (A G-Dec.) 2500 w.

Serials.

7682. The Stowell Mines. (Vic.) (A M S-Began Oct. 1—3 parts to date—30 cts. each).

7914. Phosphates in South Carolina. Edward Willis (M R-Began Nov. 11—2 parts to date—15 cts. each).

8148. Lost Mines and Mines that Have Never Been Found. Dan De Quille (M I T-Began Nov. 17—Ended Nov. 24—2 parts—15 cts. each).

8228. A New Firedamp Indicator. Ill. (C G-Began Nov. 18—2 parts to date—30 cts. each).

8258. Harney Peak Tin Mines. Josiah Thomas (E M J-Began Nov. 26—Ended Dec. 3—2 parts—15 cts. each).

8359. The Maryborough Mines. (Vic.) (A M S-Began Oct. 22—2 parts to date—30 cts. each).

8520. Notes on Ironstone Mining in Cleveland. Ill. J. C. I. Annen (E-Began Nov. 25—1 part to date—30 cts. each).

8608. L'Electricité dans les Mines. Ill. (Elec-Began Nov. 17—3 parts to date—30 cts. each).

RAILROADING.

*8030. The Pan-American Railway Surveys. Ill. J. D. Garrison (E Mag-Jan). 3000 w.

8035. Railway Turnouts. Ill. (E W-Nov. 19.) 1400 w.

8036. Discussion of the Railway Papers at the American Institute of Electrical Engineers (E W-Nov. 19.) 7000 w.

8047. A Railroad as an Iron Consumer (Ir Age-Nov. 17.) 800 w.

†8058. Railways in Native Indian States. Edward Dicey (N C-Nov.) 5000 w.

8068. Higher Speed of Railway Trains. C. A. McAlpine (E N-Nov. 17.) 3000 w.

8070. Bucking of Motors. Ill. Ludwig Gutmann (S R R-Nov.) 3500 w.

8073. The Barre Sliding Railway at the World's Fair. Ill. (S R R-Nov.) 1500 w.

8100. A Policy for the Application of Air-Brakes and Automatic Couplers. Edw. B. Wall (R C J-Nov.) 1600 w.

8101. Sanitary Regulations of the Concord and Montreal Railroad. T. A. Mackinnon (R C J-Nov.) 500 w.

8132. New York Rapid Transit (R G-Nov. 18.) 1800 w.

8135. Snow on Railroads. J. W. Harkom (R G-Nov. 18.) 4000 w.

8138. Some Remarkable Conclusions about Street Railway Motors. Editorial (R G-Nov. 18.) 3000 w.

8139. Excursion Tickets in France and Germany (R G-Nov. 18.) 1200 w.

8142. The First Railway in the Transvaal. Ill. (R A-Nov. 18.) 500 w.

8143. Reduction of Sunday Labor. Pro Bono Publico (R A-Nov. 18.) 900 w.

8145. Rail Joints. Report of the Committee of the Roadmasters' Association. Ill. (R A-Nov. 18.) 2800 w.

8146. Code of Rules for the Roadway Department (R A-Nov. 18.) 1800 w.

8147. Iron vs. Vitrified Pipe. Ill. (R A-Nov. 18.) 450 w.

8159. The Attitude of Railroads to the Anti-Pooling Section of the Interstate Commerce Law. A. F. Walker (R R-Nov. 19.) 4700 w.

8160. High Speed for Trains. Editorial (R R-Nov. 19.) 900 w.

*8176. Railways in Asiatic Turkey (I-Nov. 11.) 600 w.

8190. Elastic Traces (M N-Nov. 15.) 300 w.

8196. The St. Joseph and Benton Harbor Street Railway. Ill. (S R G-Nov. 21.) 850 w.

8197. The Tramways of Glasgow (S R G-Nov. 21.) 1000 w.

*8198. The Forfar and Brechin Railway. Ill. (I L-Nov. 11.) 1800 w.

8207. The New Plant of the Biddeford and Saco Railway Company. Ill. A. C. Shaw (E E N Y-Nov. 23.) 2400 w.

8226. Rapid Transit in London (E N-Nov. 24.) 2200 w.

8229. Accidents to Freight Trains Partially Air-Braked. Condensed Paper of Thos. A. Roberts (E N-Nov. 24.) 1000 w.

8230. The Broadway Franchise Sale (E N-Nov. 24.) 4000 w.

8232. Some Reminiscences of Early Railway Engineering in New England. Edward Appleton (E N-Nov. 24.) 1000 w.

8233. The Specifications for the New York City Rapid Transit Railroad. Ill. (E N-Nov. 24.) 1500 w.

8262. Fraser River Bridge, Canadian Pacific Railway, Mission Branch, with Discussion. Ill. H. J. Cambie (R G-Nov. 25.) 2200 w.

8263. Hydraulic Power for Railroad Terminals (R G-Nov. 25.) 3500 w.

8265. Improvements in the Westinghouse Brake. Ill. (R G-Nov. 25.) 1500 w.

8266. Special Locks for Signals near Cross-overs (R G-Nov. 25.) 600 w.

8267. Derailments Caused by M. C. B. Couplers Pulling Out (R G-Nov. 25.) 1200 w.

*8285. The South Staffordshire Tramways. Ill. (E E L-Nov. 18.) 5000 w.

*8292. Means of Communication Between Trains and Stations Along the Line. Ill. Harry Pollitt (I L–Nov. 18.) 2500 w.

*8310. Lock-and-Block Signaling. Ill. (E–Nov. 18.) 2000 w.

*8315. A Novel Hydraulic Buffer Railway Car. Ill. (Inv–Nov. 19.) 400 w.

8323. The Long and Short Haul Clause (R A–Nov. 25.) 900 w.

8324. Rules of the Chicago Elevated Railway (R A–Nov. 25.) 1000 w.

8325. An Interesting Mileage Record (R A–Nov. 25.) 400 w.

8327. Standard Ore Car—D. & I. R. R. R. Ill. (R A–Nov. 25.) 1000 w.

8328. Rail Joints (R A–Nov. 25.) 600 w.

8334. Method of Lubricating Car Axles on German Railways. Ill. (R R–Nov. 26.) 500 w.

8335. Block Signalling.—Report of Committee of Roadmasters' Association (R R–Nov. 26.) 3000 w.

8343. Series Electric Traction.—A Reply to Dr. Cary T. Hutchinson. Nelson W. Perry (E W–Dec. 3.) 2700 w.

*8349. Spanish Freight Cars. Ill. (N C B–Dec.) 600 w.

*8350. Portable Fire Pumps, West Shore R. R. Ill. (N C B–Dec.) 300 w.

*8351. Standard Fire-box Arches of the Southern Pacific Railroad. Ill. (N C B–Dec.) 800 w.

*8354. An Engineering Item. B. F. Sickels (J A E S–Oct.) 1600 w.

8381. The New Rae Car Motor Equipment. Ill. Frank B. Rae (E E N Y–Nov. 30.) 700 w.

8382. Rail Bonding and Measuring Ground Resistance. Franklin Sheble (E E N Y–Nov. 30.) 700 w.

8393. The Construction of Railway Motors. Ill. (S M–Nov. 18.) 1000 w.

†8397. The Paterson Central Electric Railway. Ill. (S R J–Dec.) 400 w.

†8398. The Jersey City and Bergen Electric Railway. Ill. (S R J–Dec.) 900 w.

†8399. Electricity in Chicago.—The Chicago City Railway Company's New Venture. Ill. (S R J–Dec.) 950 w.

†8400. The Toronto Railway Company. Ill. (S R J–Dec.) 1200 w.

†8403. Cable Traction System. Ill. (S R J–Dec.) 1000 w.

*8404. The Brooks' Compound Freight Locomotive. Ill. (R A E J–Dec.) 1100 w.

*8405. Pennsylvania Railroad Company.—Method of Determining Phosphorus in Steel. Ill. T. N. Ely (R A E J–Dec.) 2400 w.

8411. Some Reasons Why Elevated Roads are a Necessity to Philadelphia. C. W. Buchholz (R G–Dec. 2.) 1400 w.

8412. Lubrication. J. N. Barr (R G–Dec. 2.) 2300 w.

8413. Intercontinental Railroad Survey (R G–Dec. 2.) 1300 w.

8414. Commissioner Veazey's Decision (R G–Dec. 2.) 1800 w.

8417. The Design and Construction of English Traction Engines. Ill. W. Fletcher (E N–Dec. 1.) 3000 w.

8426. Some New Ideas in Locomotive Tenders. Ill. (E N–Dec. 1.) 300 w.

8445. Johnston Elevated Electric Road. Ill. (W E–Dec. 3.) 500 w.

*8446. Brooks' Compound Locomotive. Ill. (L E–Dec.) 1200 w.

*8447. Growth into Favor of the Brick Arch (L E–Dec.) 500 w.

*8448. An Irish Railway Shop. Ill. (L E–Dec.) 1000 w.

*8449. In the Oldest Locomotive Works in the World. Ill. (L E–Dec.) 800 w.

*8451. A Railroad Man's Paradise (L E–Dec.) 1000 w.

*8452. Concerning Track Ties (L E–Dec.) 700 w.

*8453. An English Way of Running Trains on a Single Track.—Webb and Thompson Electric Staff System (L E–Dec.) 1200 w.

*8454. Some Blacksmith Shop Tools. Ill. Geo. F. Hinkins (L E–Dec.) 900 w.

*8455. The Crewe Shops of the London and Northwestern,—the Largest in Great Britain. Ill. (L E–Dec.) 5000 w.

*8456. Proper Location of Machinery in Shops. W. S. Rogers (L E–Dec.) 1200 w.

*8457. Recent Express Locomotive Practice in England. Hugh Sharp (L E–Dec.) 1000 w.

*8458. Locomotive Running Among the Bushwhackers. Old Soldier (L E–Dec.) 2800 w.

8460. Railway Tank and Mansfield Automatic Water Column. Ill. (F W–Dec. 3.) 700 w.

8469. An English Accident. Ill. (R A–Dec. 2.) 1200 w.

8470. Some Interesting Locomotive Records (R A–Dec. 2.) 600 w.

8490. An Ammonia Motor for Street Railway Service (M & B–Nov.) 400 w.

8511. Lead-Lined Car Journal Bearings. Editorial (R M M–Dec.) 600 w.

8512. Tandem Compound Locomotive and Two-Cylinder Compound Locomotive. Brooks Locomotive Works. Ill. (R M M–Dec.) 1600 w.

*8523. Sleeping Cars. Ill. (E–Nov. 25.) 1400 w.

8527. The Harm of Indiscriminate Criticism. Editorial (R R–Dec. 3.) 600 w.

8528. Responsibility of Railways for Fire Losses (R R–Dec. 3.) 900 w.

8529. The Anti-Trust Law and Railway Associations (R R–Dec. 3.) 1800 w.

8530. Railroad Association Agreements Not Contracts in Restraint of Trade.—Decision of Judge Riner (R R–Dec. 3.) 8500 w.

8532. Series Electric Traction.—A Reply to Nelson W. Perry. Cary T. Hutchinson (E W–Dec. 10.) 1000 w.

8579. The Burke Cable Relay and Transmitter. Ill. (E E N Y–Dec. 7.) 1500 w.

8585. The Lake Roland Elevated Railway, Baltimore, Md. Ill. A. V. Abbott (E E N Y–Dec. 7.) 3000 w.

*8597. The Interstate Railway Company of Rhode Island. Ill. (E P D–Oct.) 4000 w.

*8619. Avantage des Voies Ferrées sur Traverses Métalliques au Point de Vue de l'Entretien (M I–Nov. 8.) 1000 w.

*8630. Chemins de Fer d' Intérêt Local et Tramways. Nature et valeur des divers types de convention pour les chemins de fer d'intérêt local. H. Hende (G C–Nov. 12.) 4000 w.

*8631. Tramways Electriques. I. Ill. Gérard Lavergne (G C–Nov. 12.) 5500 w.

*8632. Le Chemin de Fer à Crémaillère de Glion-Naye. Ill. Francis Douillet (G C–Nov. 12.) 2400 w.

†8638. Le Chemin de Fer Transsibérien. C. D. C. (R U M–Oct.) 2000 w.

8652. Fast Run on the Philadelphia and Reading R. R. Ill. (E N–Dec. 8.) 900 w.

8654. Rails 60 ft. Long and Churchill Joints; Norfolk and Western R. R. Ill. (E N–Dec. 8.) 900 w.

8655. Railway Construction in the Far Western States. Ill. (E N–Dec. 8.) 1200 w.

8656. High Speeds on Railways. Editorial (E N–Dec. 8.) 1300 w.

8680. The Kinsman Block System. F. E. Kinsman (R G–Dec. 9.) 1500 w.

8681. Settlement of a Railroad Bank. Ill. (R G–Dec. 9.) 2400 w.

8683. A New Type of Locomotive. Ill. (R. G–Dec. 9.) 1500 w.

†8691. The Insulation Resistance of Rail Circuits in Railroad Signaling. Bertram H. Mann (T Q–April-July.) 1500 w.

8701. To Maintain Rates.—Outline of and Argument for a Plan of Agreement Between Railways (R A–Dec. 9.) 6000 w.

8702. A Mountain Railway in Japan (R A–Dec. 9.) 2000 w.

*8725. The Rolling Stock Industry of Different Countries (I L–Dec. 2.) 1700 w.

*8728. Bridges on the Transandine Railway. Ill. (E–Dec. 2.) 3000 w.

*8730. Mineral Tank Locomotive for the Barry Railway. Ill. (E–Dec. 2.) 200 w.

*8731. The Second-Class Passenger. Editorial (E–Dec. 2.) 1500 w.

†8741. Compound Locomotives. Ill. F. C. Fairholme (R W–Dec.) 3500 w.

†8742. Foundry Work for Railways and Tramways. Ill. (R W–Dec.) 2000 w.

†8743. Car Lighting. Ill. (R W–Dec.) 700 w.

8750. A New Railway Time Signal. Ill. (R R–Dec. 10.) 500 w.

8751. A New Hot Water System of Car Heating (R R–Dec. 10.) 700 w.

8757. Chilled Car Wheels. Ill. S. Bolland (A M–Dec. 15.) 3800 w.

†8765. Railway Mismanagement. W. M. Acworth (N C–Dec.) 7000 w.

*8767. Signaux de Chemins de Fer. El (M I–Nov. 29.) 700 w.

Serials.

5219. The $350,000 Cable Road and the $46,000 Electric Road "Cable Railways" (S R J)–Began July—4 parts to date—45 cts. each).

6711. Railroad Motive Power (S M–Began Sept. 15—5 parts to date—15 cts. each).

6975—Railroad Blacksmithing. W. G. Lottes (L E–Began Oct.—3 parts to date—30 cts. each.

8170—The Brienz and Rothhorn Rock Railway. Ill. Chas. S. Du Riche Preller (E–Began Nov. 11—Ended Nov. 18—2 parts—30 cts. each).

8210. The Electric Subway on the World's Fair Grounds. Fred. De Land (E W–Began Nov. 26—2 parts to date—15 cts. each).

8240. On Repairing and Constructing War Railways. J. R. Bell (I E–Began Oct. 22—3 parts to date—45 cts. each).

8345. Electric Railways.—A Series of Articles from a Practical Pen. T. J. McTighe (E R N Y–Began Dec. 3—3 parts to date—15 cts. each).

8782. Systèmes Spéciaux de Traction. Resultats d'Exploitation. Emile Dieudonné (El P–Began Nov. 26—1 part to date—30 cents).

SANITARY ENGINEERING.

8066. The Use of Sea-Water for Street Watering, Sewer Flushing and Other Purposes. J. W. Cockrill (E N–Nov. 17.) 1800 w.

*8152. The Plenum System of Ventilation as Applied to the New Surgical Buildings of the Montreal General Hospital. A. C. Hutchison (Can A–Nov.) 2600 w.

*8167. Disposal of Clyde Dredgings (Eng L–Nov. 11.) 1400 w.

*8214. On the Impermeability of Floors in Public Places and Private Dwellings. Dr. Ravenez (S R–Nov. 15.) 2000 w.

*8215. The Disposal of the Dead (S R–Nov. 15.) 1500 w.

8304. Plumbing in a New York Residence. Ill. (E R–Nov. 26.) 1100 w.

†8336. A Month of Quarantine. E. L. Godkin (N A R–Dec.) 2300 w.

8418. Hygiene and Sanitation Exhibit at the World's Columbian Exposition (E N–Dec. 1.) 2200 w.

†8428. Drainage, Water-Supply or Conservancy? An Engineer Delegate to the Bengal Provincial Conference (I E–Oct. 29.) 2500 w.

*8466. Sanitation "In Ye Olden Tyme." F. W. Newcombe (C A–Nov.) 500 w.

8507. The Graham Sanitary Earthen Ware (S P–Dec. 1.) 1000 w.

*8627. Le Tout-à-l'Egout. Débarquement Flottant des Berges de Saint-Ouen et d'Epinay. Ill. Max de Nansouty (G C–Nov. 12.) 1400 w.

8653. Reports on a Sewerage System for Woonsocket, R. I. (E N–Dec. 8.) 1200 w.

*8704. School Hygiene (S R–Dec. 1.) 2500 w.

*8705. The Shone System of Drainage at Rangoon. S. B. Doig (S R–Dec. 1.) 2500 w.

*8773. Assainissement de la Seine par l'Epuration et la Nitrification des Eaux d'Egout. Ernest Bouret (G C–Nov. 26.) 1000 w.

8799. Metropolitan Sewerage System Surrounding Boston. Ill. (Sc A–Dec. 17.) 1600 w.

Serials.

5358. Sewage Purification in America (E N–Began July 14—15 parts to date—15 cts. each).

7584. Ventilation of Public Buildings (Met W–Began Oct. 29—Ended Nov. 26—2 parts—15 cts. each).

7718. Sewer Ventilation. Archibald H. Ford (S P–Began Nov. 1—Ended Nov. 15—2 parts—15 cts. each).

8126. Automatic Heating and Ventilation of a New York Residence (E R–Began Nov. 19—2 parts to date—15 cts. each).

8127. Ventilation and Heating. John S. Billings (E R–Began Nov. 19—2 parts to date—15 cts. each).

8171. The Pollution of the Aire and Calder (E–Began Nov. 11—Ended Nov. 25—2 parts—30 cts. each).

8700. Drainage Blunders. Ill. Albert L. Webster (E R–Began Dec. 10—1 part to date—15 cts).

STEAM ENGINEERING.

*8031. Liquid Fuel in Steam-Making. F. R. Hutton (E Mag–Jan.) 3000 w.

8050. The Steam Plant of the Louisiana Cypress Lumber Company (S E—Nov. 12.) 1000 w.

8108. How Steam Acts in an Engine. Ill. (B J C–Nov. 19.) 1000 w.

8114. A Scientific Boiler Furnace (A M & I W–Nov. 18.) 1000 w.

8115. The Use of Feed-Water Heaters in Rolling Mills (A M & I W–Nov. 18.) 1800 w.

8125. The Ejector and its Work. Ill. G. D. Hiscox (E R–Nov. 19.) 2000 w.

*8165. The Value of Steam Jackets. Editorial (Eng L–Nov. 11.) 1300 w.

*8166. The "Devaporator." Ill. (Eng L–Nov. 11.) 2500 w.

*8183. The Parsons Steam Turbine. Ill. J. A. Ewing (El–Nov. 11.) 2700 w.

*8192. Curious Crank Pin Failure. Ill. (P Eng–Nov. 11.) 400 w.

8223. Pittsburg Smoke (Ir Age–Nov. 24.) 1600 w.

8224. The Longitudinal Elasticity of Boiler Flues. Ill. (Ir Age–Nov. 24.) 3000 w.

8259. A Modern Boiler Plant. Ill. (B J C–Nov. 26.) 1700 w.

8261. The Safety Valve—How to Figure its Different Dimensions (B J C–Nov. 26.) 1000 w.

*8282. The Atlas Engine Works. Ill. (S–Nov.) 900 w.

8302. Machinery Hall Steam Power Plant. Ill. (E R–Nov. 26.) 1500 w.

8373. The Steam Engine in Modern Civilization. Chas. H. Loring (Ir Age–Dec. 1.) 2500 w.

8389. Cement for Joints (S M–Nov. 15.) 300 w.

8391. Utilization of Exhaust Steam for Heating Purposes. Edwin C. Shaw (S M–Nov. 15.) 1000 w.

8394. Care and Management of a Stationary Steam Boiler. D. B. D. (S M–Nov. 15.) 1400 w.

8408. Engineers' Society of Western Pennsylvania Smoke Prevention Report (E R–Dec. 3.) 1800 w.

8416. A New Graduating Steam Radiator. Ill. J. T. Hawkins (Met W–Dec. 3.) 3300 w.

8421. A Forced Draft Boiler Plant with Automatic Stokers. Ill. (E N–Dec. 1.) 900 w.

8432. A New Water-Tube Boiler. Ill. (M R–Dec. 2.) 900 w.

8473. Methods Whereby the Smoke Nuisance Can Be Largely Abated (T–Dec. 1.) 900 w.

8487. An Interesting Boiler Explosion—Importance of Testing Plates. Ill. (B J C–Dec. 3.) 1000 w.

8488. A Mill Steam Plant—Dwight Mills (B J C–Dec. 3.) 1600 w.

8499. The Steam Engine Indicator. Ill. (P S–Dec.) 2000 w.

8500. The Continuous Use of Condensing Water. Ill. (P S–Dec.) 2000 w.

8501. Circulation in Water Tube Boilers. Ill. Fritz Krause (P S–Dec.) 4500 w.

8510. Comparison of Engine Expenses. Editorial (R M M–Dec.) 1200 w.

*8515. Steam Pipes: Their Material, Workmanship and Arrangement. Abstract of Paper by W. J. Nowers Brett, with Discussion (Eng. L–Nov. 25.) 3000 w.

*8522. Heat Distribution in Steam Engines. Ill. (E–Nov. 25.) 900 w.

*8524. The Application of Forced Draft to Marine Boilers. H. Benbow (E–Nov. 25.) 1000 w.

*8553. Horizontal Compound Engine with Receiver. Ill. (I L–Nov. 25.) 400 w.

8576. Down Draft Furnaces. Otto Luhr (S E–Dec. 3.) 2400 w.

8577. The Exhaust Injector. Ill. Leander Haynes (S E–Dec. 3.) 1600 w.

8578. The Water Consumption of Engines Under Different Loads. Ill. Frank J. Roth (S E–Dec. 3.) 500 w.

8590. The Effect of Steam Jackets on High Speed Engines. Ill. R. C. Carpenter (Ir Age–Dec. 8.) 1800 w.

*8641. Boiler Room Economy. W. H. Lahman (E I–Dec.) 900 w.

8682. A Modern Boiler Plant. Ill. (R G–Dec. 9.) 1300 w.

8698. Protection of Underground Steam Pipes. Ill. R. C. Carpenter (E R–Dec. 10) 3800 w.

*8740. The Greenwich Steam Ferry. Ill. (Eng L–Dec. 2.) 1300 w.

8801. The Complete Combustion Down Draft Boiler. Ill. Albert Blanchard (S E–Dec. 10.) 1500 w.

8802. Complete Combustion as a Prevention of Smoke. Albert Blanchard (S E–Dec. 10). 2000 w.

Serials.

7439. Power Transmission in High Buildings (Ir Age–Began Oct. 20—2 parts to date—15 cts. each).

8000. Utilisation Rationnelle de la Vapeur en Sucrerie. Th. Cambier (M I–Began Nov. 1—2 parts to date—30 cents each).

8561. An Analysis of the Shaft Governor. Ill. F. M. Rites (E M–Began Dec.—1 part to date—30 cts.)

8769. Etude sur les Explosions de Générateurs de Vapeur. A. Witz (M I–Began Nov. 29—1 part to date—30 cents).

TELEPHONY AND TELEGRAPHY.

8042. The "Solid Back" Long-Distance Telephone Transmitter. Ill. (E E N Y–Nov. 16.) 600 w.

8043. The Cincinnati Distributing Telephone Pole. Ill. W. H. Robinson (E E N Y–Nov. 16.) 350 w.

8065. Telegraph Lines and Railways in China. Ill. Romyn Hitchcock (E N–Nov. 17.) 2800 w.

8072. Trolley vs. Telephone.—Full Text of the Recent Important Victory of the Trolley over the Telephone in the New York Court of Appeals (S R R–Nov.) 5000 w.

8083. The Right of States to Tax Telegraph Lines (W E–Nov. 19.) 900 w.

8099. The Swiss Telephone. S. H. M. Byers (I Age–Nov. 1.) 600 w.

8253. Western Union Progress in Chicago (W E–Nov. 26.) 2000 w.

*8306. Captain McEvoy's Hydrophone (E L–Nov. 18.) 500 w.

8554. Hudson River Telephone Company. Ill. (E R N Y–Dec. 10.) 3800 w.

8596. An Automatic Telephone (C E N–Dec.) 1000 w.

*8602. Pose du Cable d'Oran-Marseille. Ill. P. Marcillac (Elec–Nov. 3.) 2100 w.

8650. Sending Pictures, etc., by Telegraph (E A–Dec. 10.) 600 w.

8747. Fence Telephone (S M–Dec. 1.) 400 w.

8756. Felten and Guillaume's New Telephone Cables. Ill. P. (E R N Y–Dec. 17.) 400 w.

8792. Automatic Telegraph Transmitter. Ill. (E A–Dec. 17.) 700 w.

8794. The Engineering Details of the New York-Chicago Long-Distance Telephone Line. Ill. Jos. Wetzler (E E N Y–Dec. 14.) 2400 w.

Serials.

6515. Notes on Submarine Cable Work. Ill. H. D. Wilkinson (El–Began Sept. 2—6 parts to date—30 cts. each).

7331. Waxes, Gums and Resins Used in Insulating Wires. Frederic A. C. Perrine (I R W–Began Oct. 15—2 parts to date—45 cts. each).

8607. L'Industrie Française des Cables Sous-Marins (Elec–Began Nov. 10—3 parts to date—30 cents each).

MISCELLANEOUS.

*8023. Our Outlook for Foreign Markets. A. D. Pentz (E Mag–Jan.) 3000 w.

8046. Engineering Works, Present and Future in the City of New York. Ill. (Sc A–Nov. 19.) 1800 w.

8089. Hot-Water vs. Steam Heating Apparatus (S P–Nov. 15.) 700 w.

8094. Grace Darling's Jubilee (M R C–Nov. 17.) 350 w.

8095 Important Decision in the Conemaugh-New York Case (M R C–Nov. 17.) 2800 w.

*8199. The Manchester Ship Canal. Editorial (I L–Nov. 11.) 1300 w.

*8237. The Problem of the Artisan's Dwelling (J G L–Nov. 15.) 2000 w.

8272. Manufacturing in Denver (M I T–Nov. 24.) 1150 w.

*8279. The World's Columbian Exposition, its Cost and Resources. Joseph Kirkland (Ch–Dec.) 2000 w.

*8316. Navigable Balloons. W. N. Hutchinson (Inv–Nov. 19.) 2000 w.

8368. De Susini's Ether Motor. Ill. (Sc A–Dec. 3.) 2800 w.

8409. Professional Ethics and Etiquette.—Letters from M. Am. Soc. C. E. and J. T. Fanning (E R–Dec. 3.) 2000 w.

8423. An Engineering Code of Ethics. Editorial (E N–Dec. 1.) 1400 w.

†8427. The Absurdities and Shams of the Local Fund Accounts of the Madras Presidency. A Victim (I E–Oct. 29.) 1600 w.

8459. The City of Great Falls, Mon. (F W–Dec. 3.) 2200 w.

8462. Safe and Unsafe Burning Oils. D. R. Steuart (O P D R–Dec. 5.) 5000 w.

*8476. The Advantages of a Technical Education. Chas. Rodenberg (C E–Dec.) 1700 w.

†8517. Recent Applications of Paper. Ill. M. Emanuel Ratoin (P S M–Dec.) 1500 w.

*8552. Industrial Burdens in Germany and England. Editorial (I L–Nov. 25.) 1800 w.

*8562. A New and Successful Treatment for Cholera. Editorial (Inv–Nov. 26.) 2800 w.

8586. Mechanical Labor the Greatest Means of Human Culture (F M–Dec.) 1200 w.

8592. The Utilization of Niagara Falls. Ill. (Ir Age–Dec. 8.) 3000 w.

*8633. Fabrication et Emploi des Ciments. M. de N. (G C–Nov. 12.) 1000 w.

8642. Manufacture of Rubber Shoes. Ill. B. G. Underwood (Sc A–Dec. 10.) 1200 w.

*8712. Unrefined Petroleum: Recent Discoveries Permitting its General Safe Use (G W–Dec. 3.) 500 w.

†8716. Decimal or Duodecimal. Editorial (I E–Nov. 12.) 1800 w.

*8737. Peat as Fuel (C G–Dec. 2) 7000 w.

†8784. Settlement of the Congo Rubber Troubles. With Map (I R W–Dec. 15.) 1800 w.

†8785. A Visit to the Rubber Region of Peru. J. Orton Kerbey (I R W–Dec. 15.) 1000 w.

†8786. The Pará Rubber Trade Forty Years Ago. R. M. Everit (I R W–Dec. 15.) 1100 w.

†8789. The Location of a Rubber Factory. I. A. Sherman (I R W–Dec. 15.) 1000 w.

†8790. How Stock Companies are Combined. Robert M. Dean (I R W–Dec. 15.) 900 w.

†8791. The Manufacture of Rubber Toy-Balloons (I R W–Dec. 15.) 1200 w.

†8804. The Discovery of the Chinde Entrance to the Zambesi River. Daniel J. Rankin (F R–Dec.) 2500 w.

Serials.

2845. The Engineering Schools of the United States (E N–Began March 19—35 parts to date—15 cts. each).

5882. Industrial Development of the South. Richard H. Edmonds (E Mag–Began Oct—4 parts to date—30 cents each).

7747. Ships and Ship-Building on the Great Lakes (R G–Began Nov. 4—Ended Nov. 18—3 parts—15 cts. each).

7827. Etude sur la Gutta-Percha. Léon Brasse (Elec–Began Oct. 20—Ended Nov. 24—5 parts—30 cents each).

8119. Uses of Petroleum in Prime Movers (A M & I W–Began Nov. 18—3 parts to date—15 cts. each).

8407. Professional Ethics and Etiquette (E R–Began Dec. 3—2 parts to date—15 cts. each).

8637. La Prévention des Accidents du Travail dans les Usines et les Manufactures. Ill. Félix Jottrand (R U M–Began Oct.—1 part to date—45 cents).

8644. Commerce on the Great Lakes. S. G. Brock (Sea–Began Dec. 8—2 parts to date—15 cts. each).

NEW BOOKS OF THE MONTH.

(For the convenience of readers any American books will be supplied at publishers' prices by The Engineering Magazine Co. Foreign books, 25 per cent. extra.]

Allsop, F. C.=Practical Electric Light Fitting. 224 Illustrations. New York: Macmillan [8vo, cloth, 275 p., $1.50].

Baker, Ira O.=Engineers' Surveying Instruments: Their Construction, Adjustment, and Use. New York: Wiley. [12mo, cloth, 401 p., $3.]

Barker, A. S.=Deep Sea Soundings. A brief account of the work done by the U. S. S. Enterprise during 1883–1886. New York: Wiley. [8vo, cloth, 137 p., $2.]

Benjamin, Park.=Modern Mechanism. New York: Appleton. [8vo, 924 p., sheep, $7.50; half morocco, $8.50.]

Building Construction (advanced): A manual for advanced students, by the author of "Notes on Building Construction." 400 illustrations. New York: Longmans. [8vo, cloth, 255 p., $1.50.]

Byrne, Austin T.=Treatise on Highway Construction. New York: Wiley. [8vo, cloth, 723 p., $5.]

Degerdon, Walter E. = The Grammar of Wood-work: A graduated system of manual training for elementary, secondary, and technical schools. New York: Macmillan. [4to, cloth, 45 p., 60c.]

Edwards, W. Seymour.=Coals and Cokes in West Virginia: A handbook on the coals and cokes of the great Kanawha, New River, Flat Top, and adjacent coal districts in West Virginia. Cincinnati: Clarke. [8vo, paper, 165 p., 75c.]

Endlich, F. M.=Manual of Qualitative Blowpipe Analysis and Determinative Mineralogy. New York: Scientific Publishing Co. [8vo, cloth, 459 p., $4.]

Hatch, F. H.=Text-Book of Petrology: Containing a description of the rock-forming minerals and a synopsis of the chief types of igneous rocks. London: Sonnenschein. [8vo, cloth, 220 p., 7*s.* 6*d.*]

Hiorns, Arthur H.=Metal Coloring and Bronzing. New York: Macmillan. [16mo, cloth, 351 p., $1.10.]

Hopkinson, J.=Original Papers on Dynamo Machinery and Allied Subjects. New York: W. J. Johnston Co. [16mo, cloth, 249 p., $1.]

Hoskins, L. M.=The Elements of Graphic Statics. A text-book for students of engineering. New York: Macmillan. [8vo, cloth, 191 p., $2.25.]

Houston, Edwin J.=Electricity and Magnetism. New York: W. J. Johnston Co. [16mo, cloth, 306 p.]

Martinenq, B.=Traité Général des Propulseurs Employés dans la Navigation à Vapeur. Paris: Bernard et Cie. [4to, 212 p.]

Meyer, J. G. A.=Modern Locomotive Construction. New York: Wiley. [4to, cloth, 664 p., $10.]

Montillot, L.—Téléphonie Pratique. Paris: Libr. Grelot. [8vo, 510 p., 20 *fr.*]

Notes on the Year's Naval Progress. Washington: Government Printing Office. [8vo, cloth, 366 p., $1.50.]

Pont sur la Manche, Le. Exposé complet de la question, avec documents, cartes, et planches. Paris: Impr. P. Dupont. [8vo, 189 p.]

Poyser, Arthur W.=Magnetism and Electricity: a manual for students in advanced classes. New York: Longmans. [8vo, cloth, 333 p., $1.50.]

Principles of Pattern Making: written for apprentices and students in technical schools by a foreman pattern maker. New York: Macmillan. [12mo, cloth, 182 p, 90c.]

Sisson, Charles W.=The A B C of Iron. Louisville. [8vo, cloth, 99 p.]

Transactions of the Seventh International Congress of Hygiene and Demography. Vol. VI. Architecture in Relation to Hygiene. Vol. VII. Engineering in Relation to Hygiene. London: Eyre & Spottiswoode. [2*s.* 6*d.* each.]

Trevert, E.=How to Make and Use Induction Coils. Lynn: Bubier. [24mo, cloth, 84 p., 50c.]

Trevert, E.=Practical Directions for Electric Gas-Lighting and Bell-Fitting for Amateurs. Lynn: Bubier. [16mo, paper, 53 p., 25c.]

Vétillart, H.=La Navigation aux Etats-Unis, Rapport de mission. Renseignements historiques, financiers, descriptifs, et statistiques sur les ports et les voies navigables. Paris: Imprimerie Nationale. [4to, 552 p., 10*fr.*]

Witz, A.=Etude sur les Explosions de Chaudières à Vapeur. Lille: Impr. Danel. [8vo, paper, 34 p.]

Woodworkers' Manual. Dover, N. H.: The John A. White Co. [Paper, 30c.]

COMMENT & CRITICISM.

Sandstone in the Copper Region.

IN the interesting article, "The Copper Region of Michigan," by Mr. Phelps, in the October number of this magazine, a paragraph appears which requires some correction. On page 47 he states that "it has been shown by Irving and Chamberlin that the sandstone extends under the trap." On the contrary, the passage of the sandstone under the trap was shown first by myself in 1879, and published shortly afterwards. [Report on the Copper Falls Mine, 1879, pp. 3 and 4; Notes on the Geology of the Iron and Copper Districts of Lake Superior, 1880, pp. 114–116, 127.] My observations were afterwards opposed by Irving [Third Annual Report, United States Geological Survey, 1883, pp. 149–151, 154; The Copper-bearing Rocks of Lake Superior, 1883, pp. 354–359, 363–365.] and by Chamberlin [Geology of Wisconsin, 1883, I., pp. 105, 123.]

At this time they, and all other geologists except myself, contended that the sandstone abutted against a nearly perpendicular cliff, formed either by the action of the sea or by faulting. It was not until 1885, or six years later than my observations were made, that Irving and Chamberlin admitted that the sandstone passed under the trap. [Bulletin United States Geological Survey, 1885, pp. 30–37.] At this time the only important difference of opinion remaining between Irving and Chamberlin and myself was this: Is the superposition natural, as I claimed, or is it due to a reversed faulting, as they claimed?

In their paper, mentioned before, the point at issue, as well as their change of opinion, is so obscured by the discussion of side issues that it is not at all surprising that Mr. Phelps should have fallen into the error of supposing that Irving and Chamberlin, and not myself, proved that the sandstone passed beneath the traps.

M. E. WADSWORTH.

Michigan Mining School, October, 1892.

How Michigan Farmers Use the Telegraph.

IN the November number of this Magazine, in the Electrical department, mention is made of a "rural farming district in Michigan that has provided itself with a telegraph line eight miles in length." There is a line in the northern part of Senawee county which was commenced by connecting two farm-houses and has been extended from house to house and village to village until it is now over a hundred miles in length, and connects newspaper offices, doctors' offices, and stores in Adrian, Tecumseh, Clinton, Franklin, Mason, Ridgeway, and Raisin. The farmer keeps up the line across his farm and owns the instrument. One cannot enumerate the benefits it confers, but one, which the manager, Mr. Raymond Bowen, of Tecumseh, mentioned to me to-day, is worthy of special mention. The election returns came in very early from towns on the line and were given to the agent of the Associated Press *in exchange for their dispatches*, which were immediately sent over the wire to each farm-house. In receiving news the farmer of Senawee county had an advantage over the business man of New York and Chicago.

"I could not sleep last night," said Mr. Bowen, "for I *lay in bed* listening to the instrument ticking off the election news."

What do you think of that? The Company is named the Commercial Telegraph Co.; but it is a misnomer; it should be named the Farmers' Telegraph Co., for it is such. The system should be extended until every farm-house is bound to every other with cords of steel.

GEORGE S. TIFFANY.

Tecumseh, Mich., November 9, 1892.

Sanitation at Chautauqua.

MY attention has been called by the trustees of the Chautauqua Association to an article which appeared in the October number of THE ENGINEERING

MAGAZINE, in the department of Architecture, in which reference was made to the sanitary condition of Chautauqua.

I desire to make a statement in regard to the collection and disposal of the sewage from the public closets there. These closets contain water-tight vaults, which are cleaned periodically, and during my visit there last summer I personally inspected several of them, and never have I seen such a cleanly condition, of conveniences of this kind, as I found there. I think it reflects great credit upon those who have had the oversight of this particular matter, and that it is due to the vigilance they have exercised as well as the methods they have employed, that, without any sewers, and with such a large collection of people, oftentimes fluctuating in numbers, the arrangements should be kept in such a cleanly, inoffensive, and satisfactory condition. I have designed and am superintending the construction of a system of sewerage and method of sewage disposal for Chautauqua, which, when completed the coming spring, will, it is believed, place Chautauqua in a thoroughly sanitary condition as regards the collection and disposal of its sewage.

I write this thinking that perhaps the article to which I have referred above was a little too sweeping in what it included, and tended to give a wrong impression, or at least did not give credit to one of the redeemable features in connection with the lack of sewerage.

SAMUEL M. GRAY.

Providence, R. I., November 21, 1892.

The Mississippi Problem.

MY attention has been called to a communication in the December number of your magazine, signed "A Southern Engineer," containing such loose and extravagant statements that it is difficult to believe that they proceed from an engineer at all, or from any person who is familiar with the Mississippi river. Such assertions should be authenticated by a responsible name, that the public may have the means of judging of the competency and credibility of the author. I shall not enter into a controversy with an anonymous writer; but if your correspondent will make known his name and address in your columns, I will be happy to answer him, if the editor so pleases through the same medium. Very respectfully,

WM. STARLING.

Greenville, Miss., December 13, 1892.